Newport Research Facility

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Report for the year ended 31st December 2011

This report follows in sequence from the Annual Reports of the Salmon Research Agency of Ireland Inc. and the Salmon Research Trust of Ireland Inc.

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Summary

1. The Salmon Research Agency of Ireland merged with the Marine Institute on the 1st July 1999 into Aquaculture & Catchment Management Services and in 2010 the group merged with Fisheries Ecosystem Advisory Services. This report provides a continuation of the data records for the Burrishoole facilities.

2. The total rainfall recorded in Furnace in 2011 was 1826.9 mm. Months of relatively high rainfall in 2011 were February, May and August to December and months with low rainfall were January, March, April, June and July.

3. The environmental programme was maintained in the catchment with the network of rain gauges, water level reorders and river and lake monitoring stations all in operation.

4. The total release of micro-tagged salmon smolts of Burrishoole reared origin into L. Furnace amounted to 32,757. Smolts were released as four core and one SLICE treated group, ranging in mean weight from 53g to 64g. Two additional groups of tagged smolts were released in 2011; one of wild Burrishoole stock (5,265) and 7,897 smolts of Burrishoole origin MSW females crossed with Burrishoole ranch males. Smolts were released into Furnace on 28th April 2011.

5. Testing of wild salmon kelts (n=66) proved negative for IPNV and *Anasakis* levels were generally low.

6. In 2007, the Irish Government introduced a cessation of drift netting for salmon at sea and this was continued in 2011.

7. A total of 523 wild grilse and 7 previously spawned grilse (psg) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded was 50. The total run of wild grilse, including the Furnace rod catch (0), was 523 + 7 previously spawned grilse.

8. Returning adults were checked for net mark damage; 0.8% (n=491) of wild grilse (all in July) and 1.4% (n=1043) of reared grilse (in June, August and September) had net marks recorded.

9. The maximum spawning escapement was 512 wild and 36 reared fish.

10. A total of 6627 wild salmon smolts were recorded in the downstream trap in 2011. The wild return of 2010 smolts as wild grilse in 2011 was 7.5%. The ova to smolt survival at 0.34 – 0.30%.

11. Wild kelt survival was 35.5% and kelt return as previously spawned grilse later in the year was 4.1%.

12. The return to freshwater of the Burrishoole reared grilse recorded was 2.7%, similar to that in 2010.

13. A total of 68 wild sea trout and a further 87 non-silvered trout migrated upstream through the traps in 2011. Of the sea trout, 18 were adults and 50 (73.5%) were finnock.

14. The 2011 sea trout smolt run amounted to 620 smolts.

15. The percentage of smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1989 it collapsed to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's between 4 & 10%, rising to 16.7% in 1999. Finnock return in 2011 was 8.1%.

16. Silver eel trapping continued with the total run amounting to 1969 with the run mainly in September and October. After that, the run dropped off and few eels were recorded in November and December or in early 2012.

17. A total of 122 salmon were caught in the Rod Fishery in 2011. The catch consisted of 36 wild fish and 86 reared salmon. All wild fish were returned alive. There were 56 sea trout reported caught on L. Furnace and one on L. Feeagh and these were returned alive. 222 brown trout were also reported caught on L. Feeagh in 2011.

18. 2011 marked the completion of 21 years of catchment electrofishing surveys for juvenile salmonids and eel.

19. Eel fyke net surveys of Bunaveela, Feeagh and Furnace were undertaken in 2011. The data from these surveys were included in the National eel database.

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1 Introduction

The Salmon Research Agency merged with the national Marine Institute on the 1st July 1999. The staff of the Agency were absorbed into the Aquaculture and Catchment Services Group of the Institute and the research facilities at Furnace have undergone a programme of upgrading and improvement. The core monitoring work of the Agency will continue but its unique experimental facilities, both in relation to aquaculture and wild fisheries, will be fully utilised within the context of the Marine Institutes published Research, Technology, Development and Innovation Strategy. The merger has resulted in an increased national role for the work of the Agency and a consolidation of the trap and laboratory facilities at Newport. In 2010, the fisheries and catchment team based in Newport were integrated into the Fisheries Ecosystem Advisory Services group (FEAS) of the Marine Institute.

This report represents a continuation of the Annual Reports published by the Salmon Research Agency of Ireland. The data presented creates a unique record of fish rearing and wild fish census data for the past 42 years. This data is an essential component in the local, regional and national management of salmon, sea trout and eel and is becoming ever more valuable in the light of increasing pressures on natural stocks, such as exploitation, habitat degradation and global climate change scenarios. The fish monitoring facilities in Newport, along with the reared and ranched salmon stocks held in Burrishoole, are also essential for the evaluation of novel enhancement techniques, alternative stocks and ranching and evaluation of interactions between farmed, ranched and wild strains.

2 Environmental Data

2.1 Mill Race Data

2.1.1 Rainfall

Daily meteorological data were collected during 2011 at the manual Met Station in Furnace. The monthly rainfall figures for 2008, 2009, 2010 and 2011 are given in Table 2.1, along with the annual totals for the years 1977 to 2011. Months of relatively high rainfall in 2011 were February, May and August to December. Low rainfall was recorded in January, March and April and also in June and July. The total rainfall was 1826.9mm in 2011. Daily rainfall amounts are shown in Figure 2.1.

Table 2-1: Monthly rainfall totals (mm) for the Furnace Station in 2008, 2009, 2010 and 2011 and the annual totals for 1977 to 2011.

Month	2008	2009	2010	2011	Year	Total	Year	Total
January	227.0	143.8	86.0	93.4	1977	1579.7	2000	1833.2
February	137.5	61.8	69.1	192.7	1978	1592.2	2001	1298.7
March	230.2	124.9	82.5	82.6	1979	1653.3	2002	1715.9
April	67.6	92.8	48.8	89.2	1980	1792.1	2003	1353.2
May	29.1	128.8	48.2	161.1	1981	1646.8	2004	1641.3
June	95.8	67.5	44.3	96.1	1982	1609.6	2005	1608.2
July	62.0	243.8	129.3	40.5	1983	1495.9	2006	1550.7
August	218.9	254.7	100.2	135.1	1984	1556.6	2007	1576.8
September	178.9	87.1	262.4	199.1	1985	1584.1	2008	1805.0
October	249.4	132.3	130.9	276.7	1986	1886.9	2009	1793.9
November	179.3	322.6	240.1	167.0	1987	1373.6	2010	1311.6
December	129.3	133.8	69.8	293.4	1988	1715.2	2011	1826.9
					1989	1583.9		
Total	**1805.0**	**1793.9**	**1311.6**	**1826.9**	1993	1473.4		
					1994	1757.1		
					1995	1382.5		
					1996	1286.6		
					1997	1351.6		
					1998	1830.9		
					1999	1949.1		

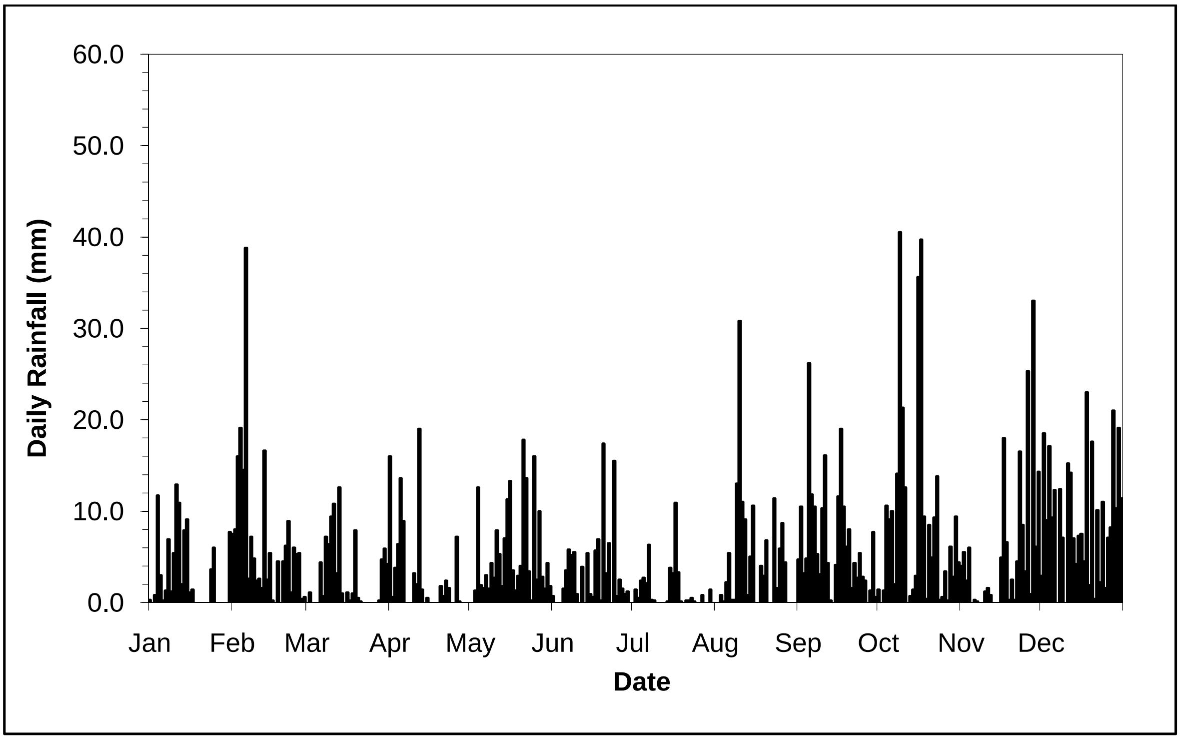


Figure 2-1: Daily rainfall amounts (mm) recorded in the Mill Race manual weather station.

2.1.2 Water Level and Temperature

Water Level: Difficulties were experienced in 2003 with the automatic water level chart recorder. An OTT Orphimedes automatic water level recorder was installed in late January 2004. Water levels are recorded every 15 minutes and are presented in Figure 2.2 recorded at 00:00 hrs. This approximates to the mid-night readings from the old chart recorder.

Water Temperature: In 2004, a TidbiT temperature logger was installed along with the chart recorder and this records water temperature every 30 minutes. The temperature logger data are presented in Figure 2.3, recorded at the closest time to midnight (<30mins).

In 2011, water temperatures (recorded at midnight) fell to a minimum of 2.32^{O}C on the 7th January. There was a fairly steady increase in temperature from then until the end of April to a peak of 11.7^{0}C in late April. There was no increase in temperature in May followed by a further increase to the 27th July to a maximum of 15.6^{O}C, a full four degrees lower than in 2009 and one degree lower than in 2010. The temperature dropped fairly steadily from the end of July for the rest of the year to a minimum of 4.4^{O}C on the 25th of December, two degrees warmer than in 2010.

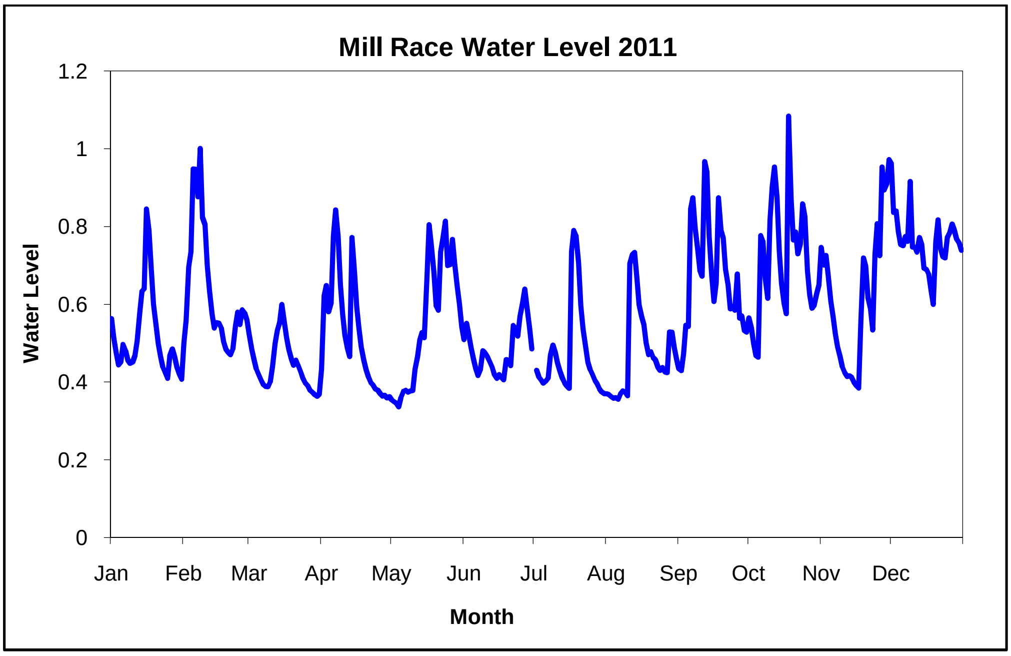


Figure 2-2: Water levels recorded at mid-night for the Mill Race using an OTT Orphimedes automatic water level recorder.

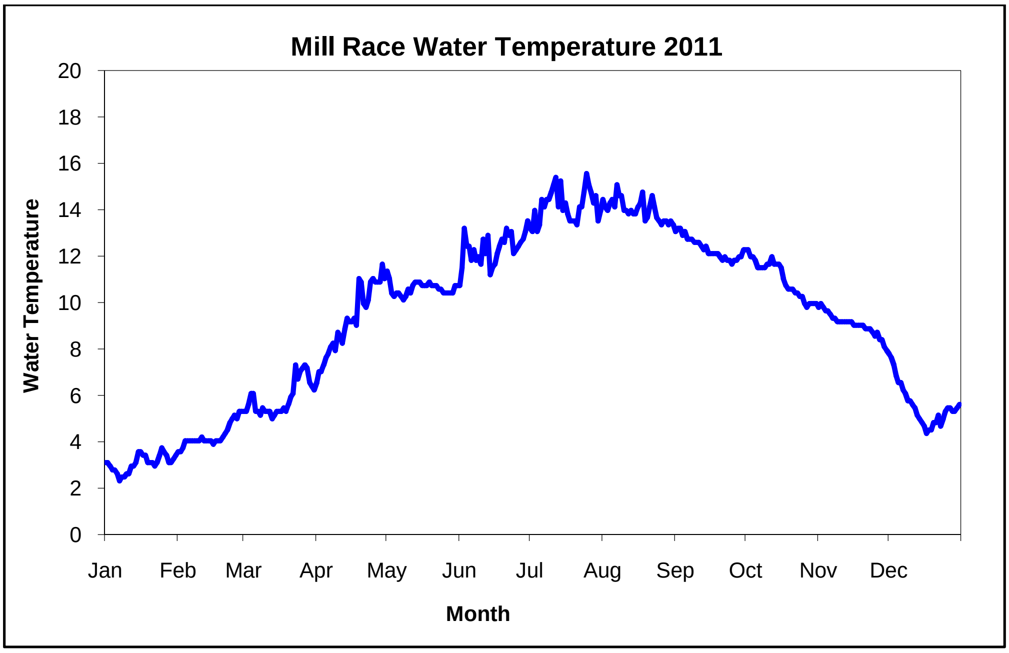


Figure 2-3: Water temperatures (°C) recorded, by TidbiT data logger, at mid-night for the Mill Race.

2.2 Catchment Programme

2.2.1 Background

In recent years, the combined effect of extreme weather events with impacts of land use, have had a significant effect on the erosion rates recorded in many upland areas. Since 1995 the Marine Institute has operated a series of automatic monitoring stations to monitor these impacts, the influence of weather patterns and to attempt to quantify the transport of suspended sediments in the Burrishoole catchment. These automatic stations, funded under EU LIFE and National programmes, include two lake stations (AWQMS – installed under EU LIFE 93 and ERDF 2008), which have various meteorological instruments included with a suite of underwater temperature and water chemistry sensors, and three river stations, (ARMS – installed under EU LIFE 98), which are equipped with sensors for measuring water temperature, water level, pH, conductivity, dissolved oxygen, and turbidity. The automatic monitoring stations are also equipped with a telemetry system for relaying high-resolution data back to the laboratory.

In addition, the Institute has also deployed additional core-funded instrumentation in the catchment including temperature loggers, 11 water level recorders and 15 data-logging rain gauges in the Burrishoole catchment, two in the Owengarve catchment and two in the Owenduff catchment, which will build up a detailed profile of precipitation in a mountainous catchment.

Water levels within the catchment are measured using a series of OTT Orpheus mini's water level recorders which measure water level at fifteen-minute intervals. These data can be used to calculate water volumes on an hourly or daily basis. An important feature of the monitoring network is the ability to simultaneously collect data from river, lake, and climatic instruments. The continuing integration of this data with ongoing fish population surveys is an important component of the research programme.

In 2007, the Burrishoole catchment became a member of the Global Lake Ecological Observatory Network (GLEON: http://www.gleon.org), an association of limnologists, information technology experts and engineers whose goal is to establish a persistent network of lake ecology observatories (http://www.gleon.org). Data from these observatories (of which Lough Feeagh and Lough Furnace, both located in the Burrishoole, are included) will allow a better understanding of key processes, such as the effects of climate and land use on lake function, episodic events and carbon cycling within lakes. The research involvement in GLEON is a continuation of the work carried out under various national and internationally funded projects. In 2012 the Marine Institute will co-host the GLEON meeting in Newport.

Previous research identified a scientific gap in knowledge in terms of understanding the implications of present and projected future changes in stream flow, water temperature, pH levels and DO concentrations on fish productivity in the catchment. To address this, in 2008 and 2009 a multidisciplinary team of scientists, funded within the SSTI Climate Change programme, from the National University of Ireland Maynooth (NUIM), TCD and the Marine Institute, undertook an analysis of both present and likely future climate impacts on the catchment with a view to furthering the understanding of the interlinkages between climate, climate change, and the freshwater ecosystem. This report entitled *RESCALE: Review and Simulate Climate and Catchment Responses at Burrishoole*, (Fealy *et al*. 2010) builds on the wealth of scientific endeavours previously undertaken on the catchment and represents the collaborative efforts of the multidisciplinary research team.

Fealy, R., Allott, N., Broderick, C., deEyto, E., Dillane, M., Erdil, R.M., Jennings, E. McCrann, K., Murphy, C., O'Toole, C., Poole, R., Rogan, G., Ryder, L., Taylor, D., Whelan, K. & White, J. (2010). RESCALE: Review and Simulate Climate and Ctachment Responses at Burrishoole. Marine Institute 2010; 138pp.

2.2.2 The 2011 Programme

The environmental programme continued in 2011 with most of the catchment work in the first Quarter being battery replacements and equipment maintenance backlog after the very severe cold weather conditions at the end of 2010. A complete service and rebuild of the Winch on Lough Furnace took place in August, while software, firmware upgrades to each of the monitoring stations were carried out later in the year.

Rainfall in the Burrishoole was high in 2011, especially in the last two Quarters of the year, with 2999.4mm of rain recorded at one of the stations in the Nephin hills. The resultant floods severely damaged the Glenamong river station, ripping wires from the sensors and putting the site out of service. It is proposed to relocate the Station further upstream with the conditional support of Coillte and NPWS.

Sites decommissioned

All five automatic water quality monitoring stations were operational in 2011. As a consequence of reduced staff and increased work load, it was decided to decommission some environmental sites in the catchment; Water Level Sites-Red Area sites 1 & 3, Rain gauge Site- Ridge and Salmon Leap.

2.2.3 The Black River

The main river flowing into Lough Feeagh is the Black River, also known as the Shramore River. A water level recorder is installed approximately 500m above the lake. Figure 2.4 shows the average daily water level and Figure 2.5 shows the average monthly water levels from 2001 to 2011. The high rainfall event in July 2009, mentioned in Section 2.1.1 of the 2009 report, can be seen reflected in the water level in the Black River followed by the unusually dry winter/spring period in 2010.

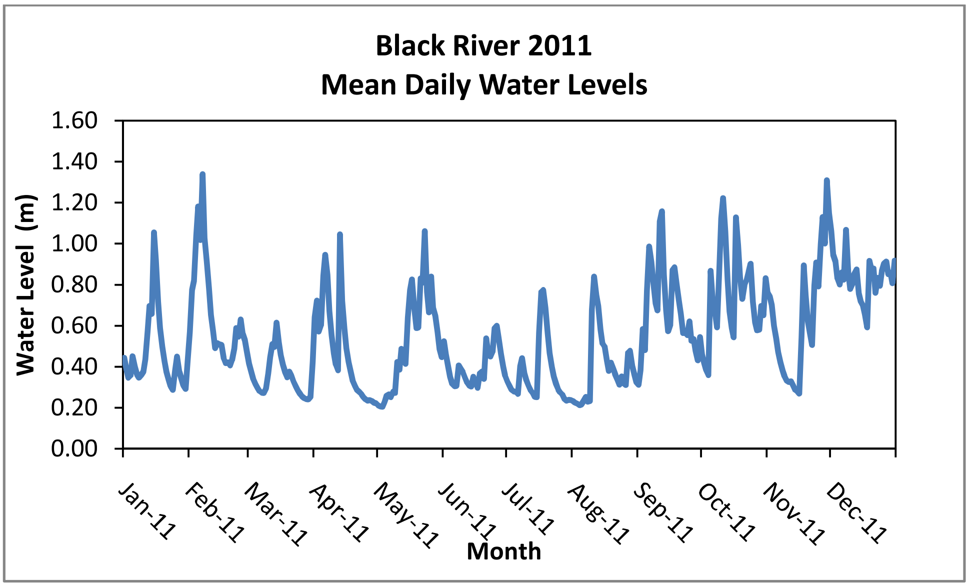


Figure 2-4: Daily mean water level for the Black River, 2011

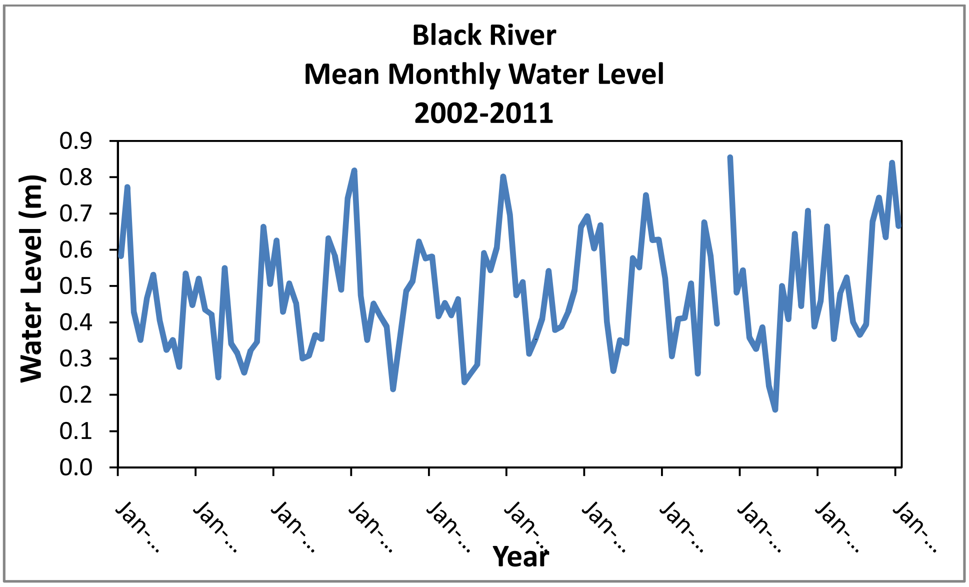


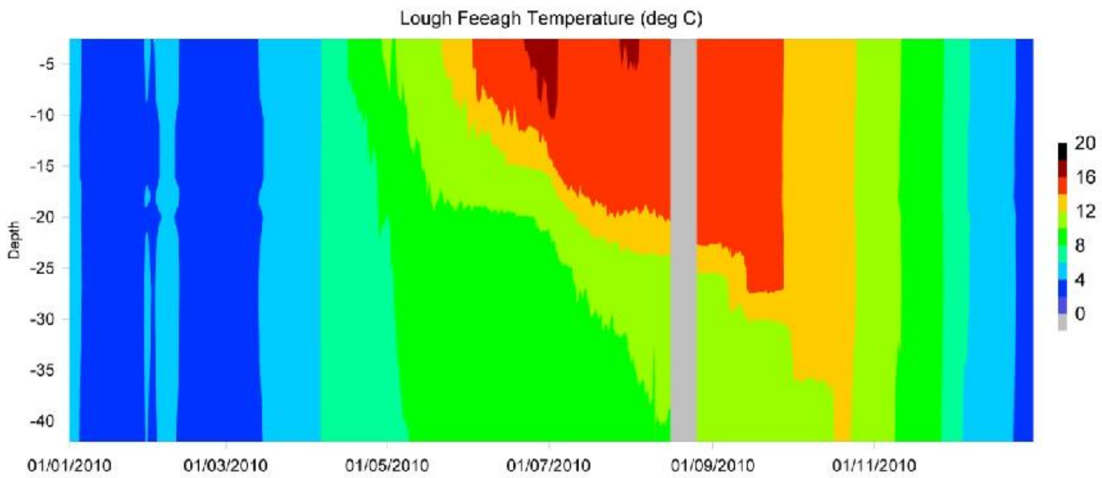
Figure 2-5: Monthly mean water levels for the Black River, 2002-2011.

2.2.4 Lough Feeagh

Lough Feeagh is situated in the Burrishoole catchment in the west of Ireland close to the Atlantic coast and is therefore strongly affected by the temperate oceanic climate that predominates in the region. The water is soft (pH range 5.7-6.9 in 2007, alkalinity 6mgl-1 CaCO3) and highly coloured (2007 mean of 82 mgl-1 PtCo), and is oligotrophic, with Chlorophyll "a" ranging between 1 and 2 µg l-1. Mean annual Total Phosphorous is 11 µg l-1 (2006) and Total Nitrogen is 0.69 mgl-1 (2006). The Lough Feeagh AWQMS measures various parameters using a Hydrolab datasonde 5, two Chelsea scientific minitrackas and a Seapoint fluorometer (pH, dissolved oxygen, temperature and conductivity, turbidity, Chl *a* fluorescence and CDOM fluorescence). These parameters are measured every five minutes and an hourly average is calculated for all the parameters. There is also a thermister chain and various weather instruments continually monitoring variables such as barometric pressure, wind speed and wind direction.

The Lough Feeagh AWQMS operated well all year, with only short time periods of missing data. After a cold winter (similar to that of the previous year), the lake began to warm up from March, and stratified over the summer (Fig. 2.6). The water temperature in the epilimnion was not quite as warm as previous years (Fig. 2.7).

Lake water temperature ranged from 3.21-16.71°C in 2011 and the lake only weakly stratified for a relatively short period in July and August. The lake usually stratifies between May and October each year (Figs 2.6 & 2.7). The effect of the cold winters in 2009/2010 and 2010/2011 can be clearly seen in (Figs 2.6 & 2.7).



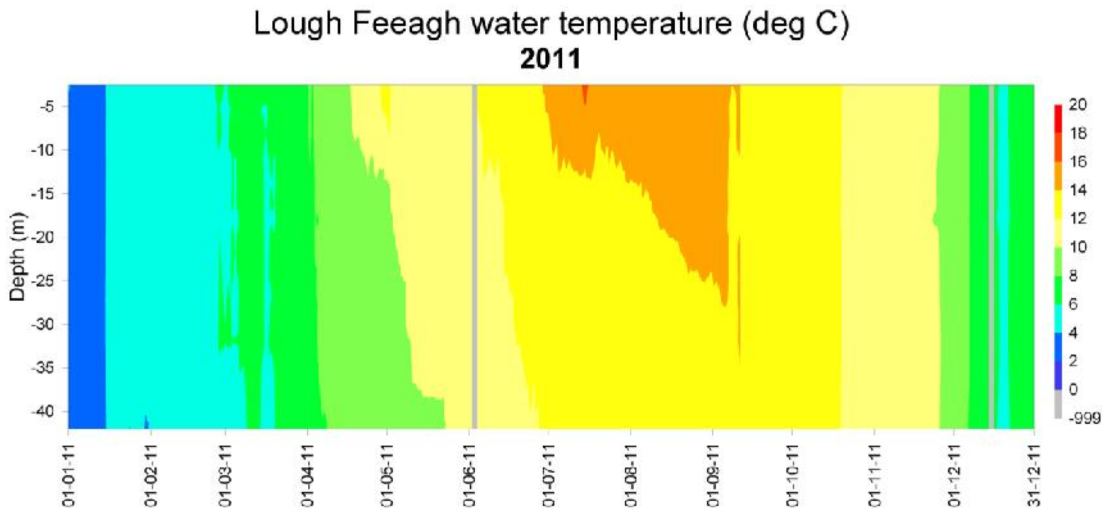


Figure 2-6: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2010 (top) and 2011 (bottom). The grey denotes missing data.

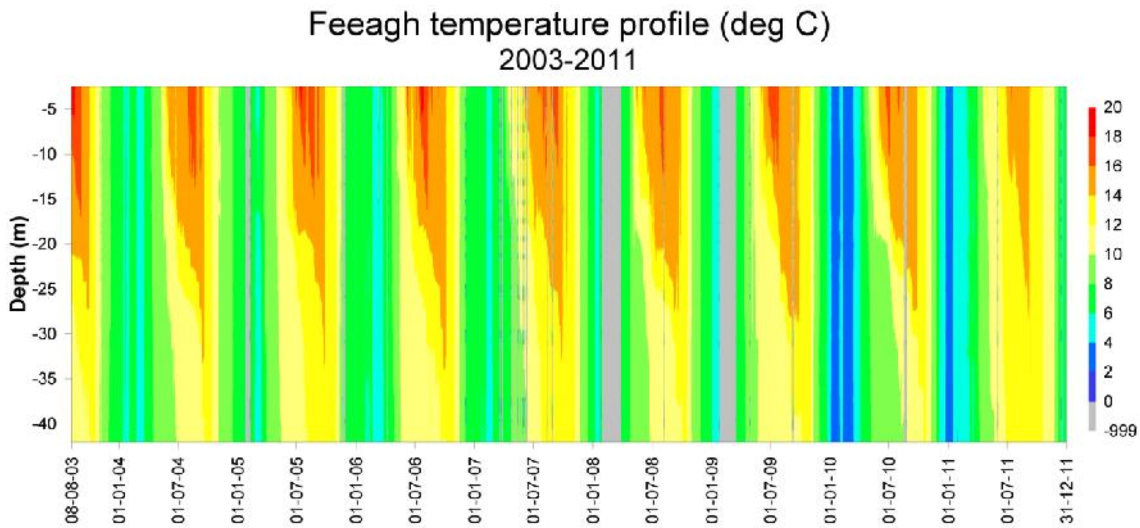


Figure 2-7: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2003-2011. The grey denotes missing data.

2.2.5 Lough Furnace

Lough Furnace is situated in the lower end of the Burrishoole catchment. Lough Furnace, (2km from north to south at its widest point, covering an area of 170ha, max depth is 21m with an average depth of 7m) is a cryptodepression tidal lagoon lake. Sea water enters the lake during spring tides but the freshwater exchange ensures relativity low salinities at the surface throughout the year. Initial results indicated that in 2008 the pH ranged from 7.0- 8.1 and dissolved oxygen levels decreased dramatically below 3m in the lake. The lough is thermally stratified throughout the year with spring and autumn inversions with accompanying halo- and oxyclines (Fig. 4.8). Monitoring of L. Furnace commenced in the early 1970s and automatic daily monitoring commenced in May 2008. This AWQMS (Fig. 2.8) has a Datasonde DX5 attached to a profiling winch, enabling temperature, conductivity, dissolved oxygen (% and mg/l), salinity and pH profiles of the lake to be taken. The winch profiles the lake 4 times a day (6am, noon, 6pm and midnight), taking four hours to run a profile and is parked for two hours. There is also a nephlometer and fluorometer positioned one meter below the water column. All parameters are measured every 2 minutes and an hourly average is then calculated. A weather station is also fully functional on the AWQMS measuring wind direction, wind speed, radiation, relative humidity and barometric pressure.

Figure 2-8: The Automatic Water Quality Monitoring Station (AWQMS) on L. Furnqace (left) and the meteorological instruments attached (right)

Lough Furnace exhibited a permanent halocline between 4 and 5 metres through 2011, with dissolved Oxygen and temperature being significantly lower at depth (Fig. 2.9). No mixing between the epilimnion and hypolimnion occurred (Fig. 2.10), and the main algal productivity occurred just above the halocline during the spring and summer (Fig. 2.10). Our increasing familiarity with the technicalities of the Furnace AWQMS meant that data for 2011 was more continuous than in previous years, with fewer large data gaps.

Three years of continuous data from the AWQMS on Lough Furnace have now being collected, and show that, in general, the halocline has been stable over that time period, but the depth varies between 4 and 6 metres. Summer temperatures in 2011 were lower than the previous years, as was algal productivity (Figs. 2.11 & 2.12).

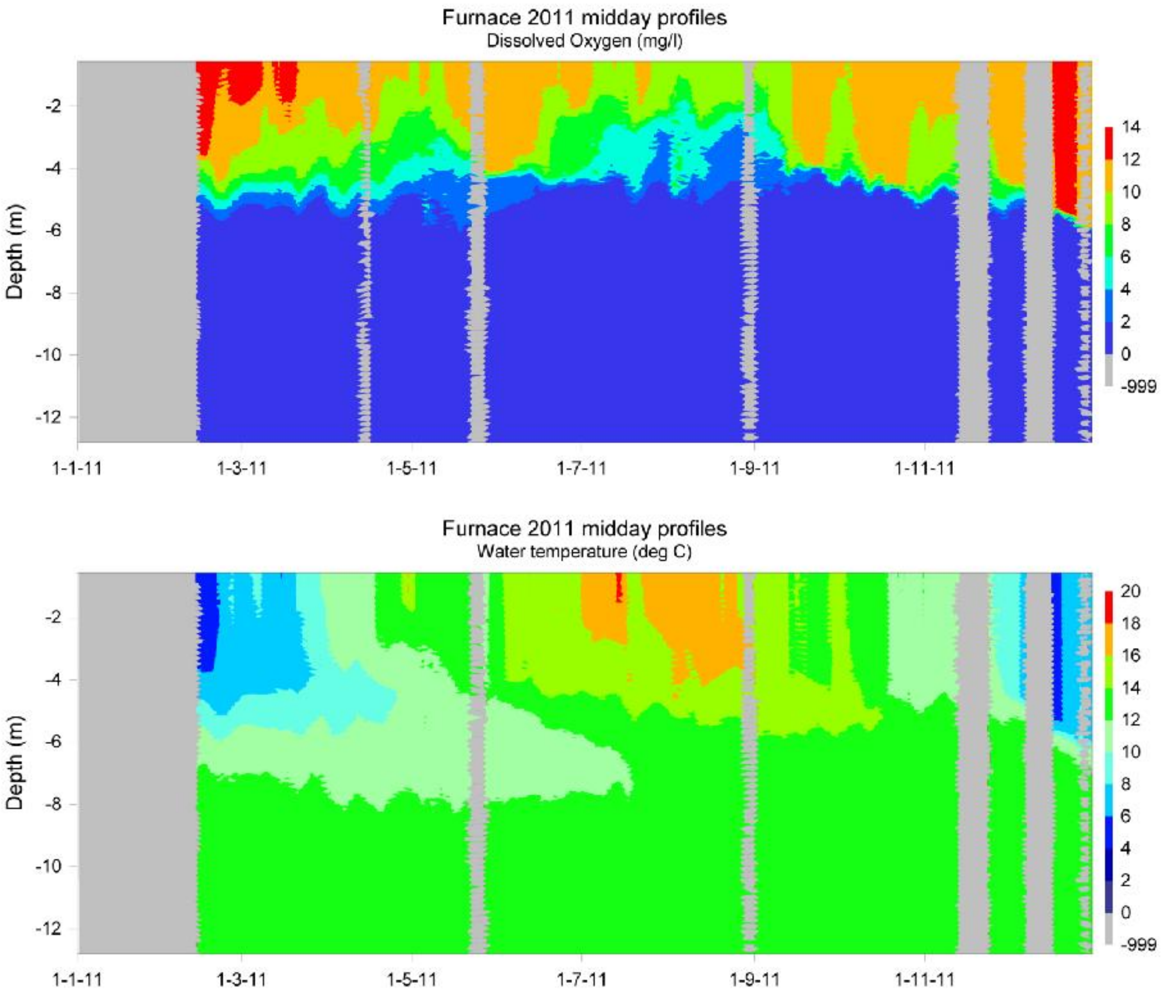


Figure 2-9: Oxygen (top) and temperature (bottom) profiles from Lough Furnace, 2011. Grey indicates missing values.

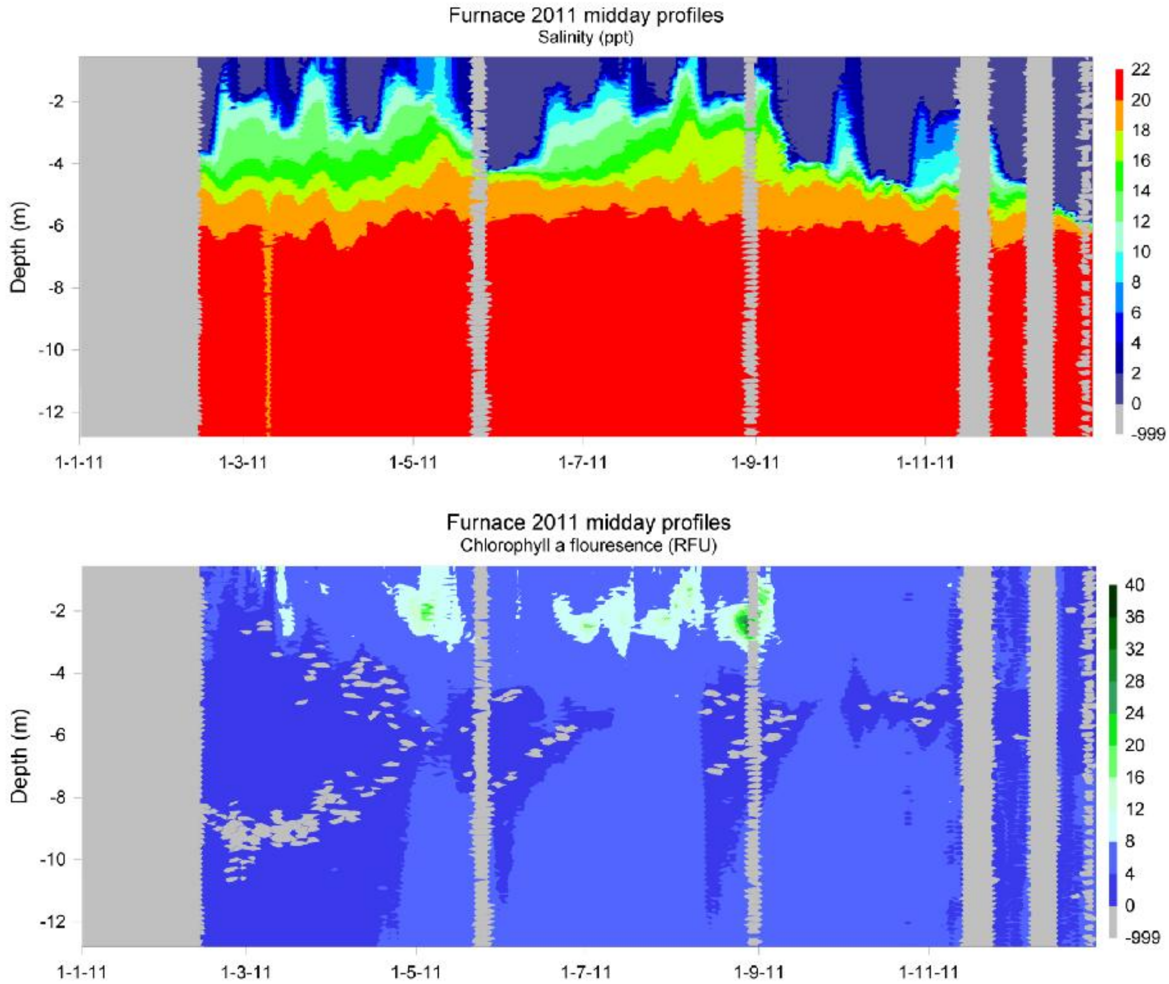


Figure 2-10: Salinity (top) and Chlorophyll *a* (bottom) profiles from Lough Furnace, 2011. Grey indicates missing values.

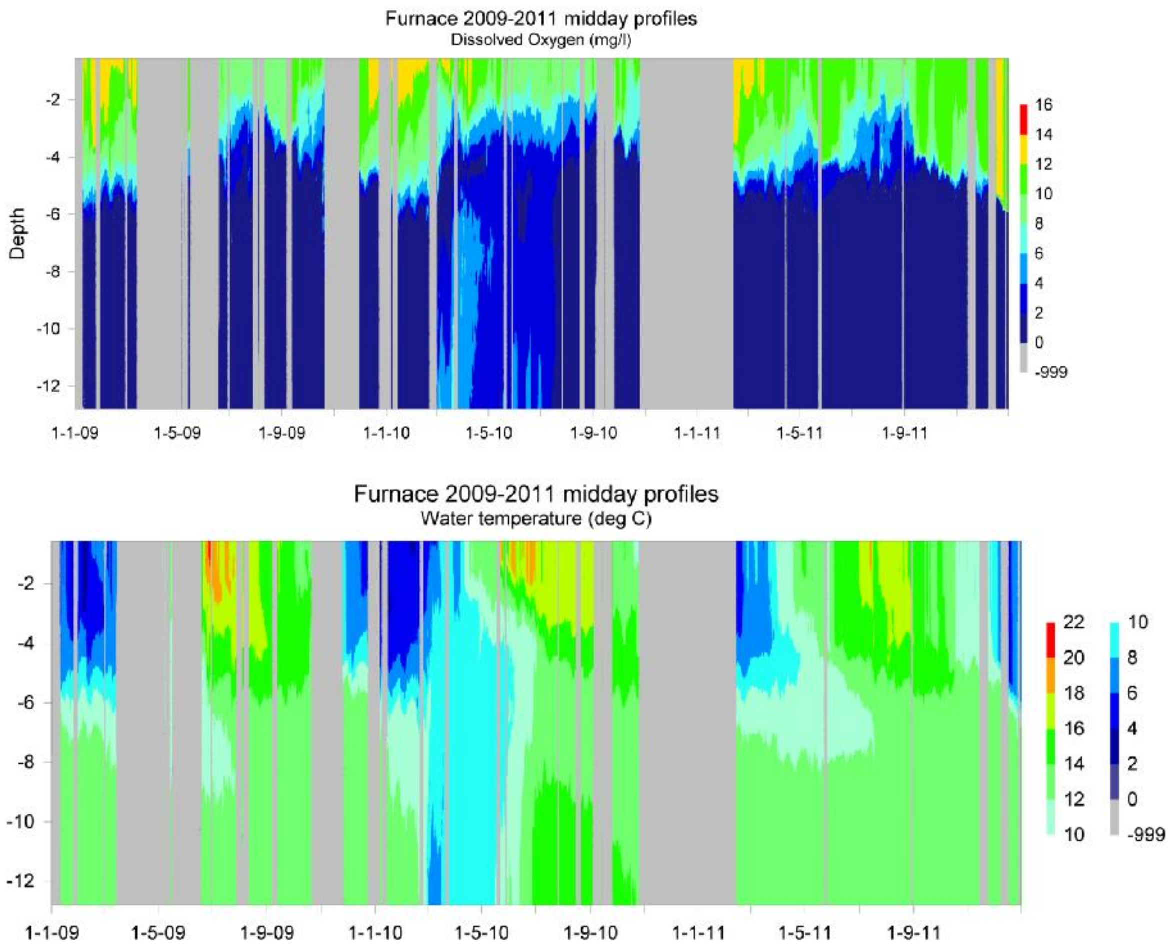


Figure 2-11: Oxygen (top) and temperature (bottom) profiles from Lough Furnace, for 2009 to 2011. Grey indicates missing values.

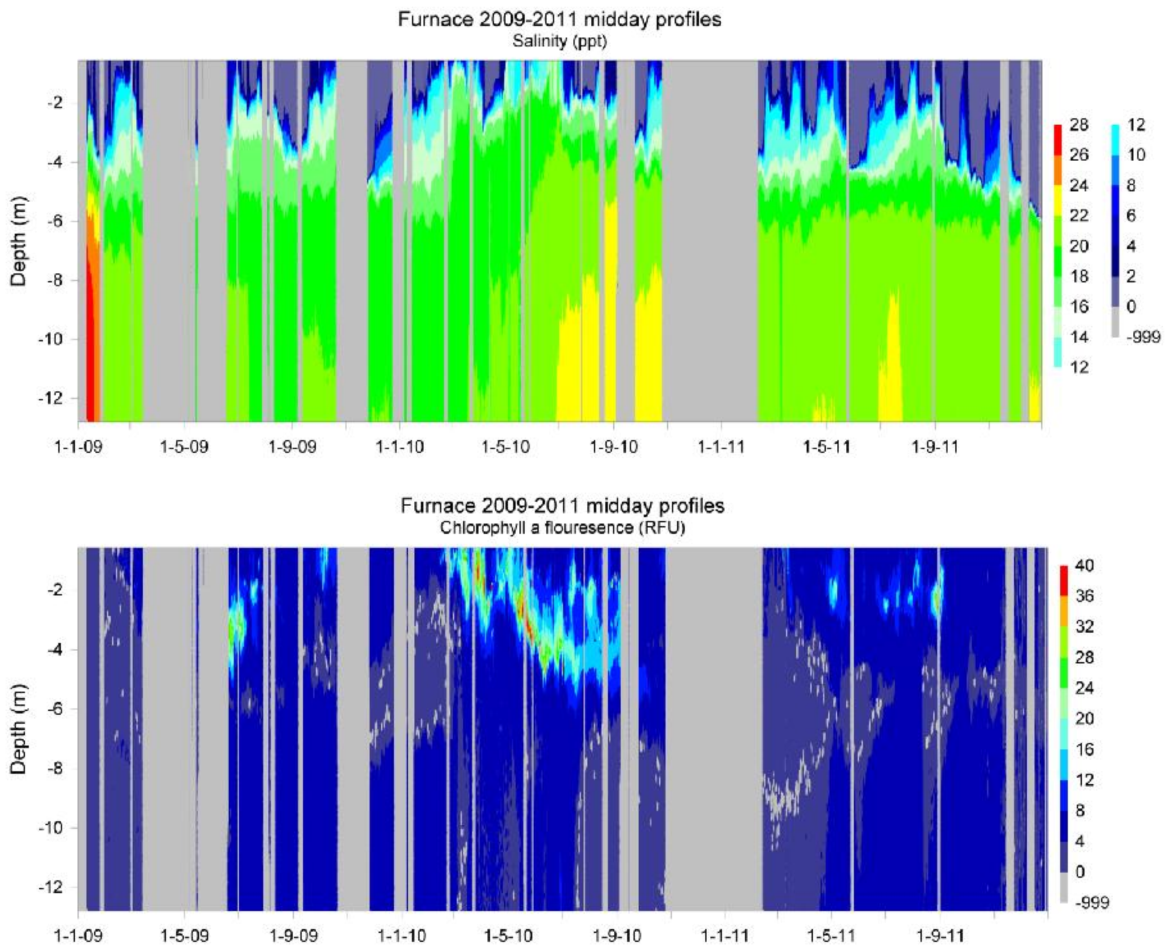


Figure 2-12: Long term Salinity (top) and Chlorophyll *a* (bottom) profiles from Lough Furnace, for 2009 to 2011. Grey indicates missing values

3 Salmonid Rearing

3.1 Salmon Stocks 2010

3.1.1 Ranching

The total release of microtagged smolts of ranched Burrishoole grilse origin into Lough Furnace was 32,757. Five groups, including one group treated with 'SLICE' for protection against lice infestation during the early weeks at sea, were released on 28th April 2011. Mean weights ranged from 53 to 64gms.

Two additional groups of salmon smolts were microtagged and freeze-branded in 2011, as the number of ranch parents available in December 2009 was low (43 females, 39 males). Both groups were released on 28th April 2011; 5,625 derived from wild Burrishoole stock (brand T), averaging 50gm and 7,897 derived from 'Burrishoole' origin MSW females (from Delphi) crossed with Burrishoole ranch males (brand O), averaging 62.5gm.

Tag code details are shown in Table 5.1.

3.2 Salmon Stocks 2011

Burrishoole ranch salmon were hatched in 2011 but all experimental groups produced using wild salmon were destroyed (see **Virological Screening of Wild Salmon Stocks 2011).**

Growth and survival were good with an overall survival for 7 stripping groups of 91%, (range 80% - 95%) from eyed ova to grading in August. First feeding commenced in the first group (stripped on 13th December 2010) on 21st April and in the last group (stripped on 24th January 2011) on 4th May 2011. Water temperatures were optimal for first feeding > 10^0 C. Grading was carried out during August and in October the progeny of the earliest and latest stripping groups (1st 6th and 7th stripping dates) were retained as separate groups and all other groups were mixed to produce core medium and large release groups.

Parasite levels were low and few salt or formalin treatments were required. Stocks remaining in December 2011 comprised 50,104 Burrishoole ranch salmon parr.

3.3 Salmon Stocks 2012 (Grilse ova laid down in 2011)

An estimated 60.6% of all returns and 57.7% of ranch grilse returns were processed between April and August. Broodstock collection commenced from August 26th onwards and salmon were held in ponds until transfer to the broodstock holding pond on 8th September 2011 (43 males, 38 females). Broodstock collection continued into December and in total, 382 ranch adults (181 females, 201 males) were held during the stripping period.

Water temperatures fell from around 9^0 C in early December to 6^0 C in early January. Stripping commenced on December 13th 2011 and extended over a period of 7 weeks to January 31st 2012. An estimated 468,000 green ova were produced by 147 females. Ova from parents with no tag or from non-indigenous experimental groups, as indicated by microtag, were removed. Approximately 415,700 green ova were produced by 129 ranch grilse females. The average fecundity value was 3,197 ova per grilse female (n=94) and 3832 ova per 2SW female (n=2).

Thirty four females were not used for ova production, including 20 females which failed to strip by the end January. A proportion of each family, from confirmed Burrishoole stock, was retained in the hatchery from each of the seven stripping dates, totalling 74,167 eyed ova from 114 females and 119 males. Eyed ova from twelve females stripped on 24.1.12, were sent to Screebe Hatchery for the production of salmon smolts for the National Microtagging Programme. Ova quality and survival was good.

Eyed ova (25,856) from 2SW Delphi ranch parents were transferred from Delphi Hatchery on 17th February 2012 and a replicate batch retained for on-growing in Delphi. Salmon smolts will be ranched and released from both sites in 2013, to assess the return rate and run timing of adult returns.

Broodstock condition was good throughout the holding period. Thirty ranch salmon broodstock were sampled in January 2012 by the Marine Institute Fish Health Unit and subsequently were found to be disease free. Salmon (n=36) were screened for the presence of the parasite Anasakis in October 2011(n=6) and January 2012 (n=30) and although Anasakis was noted in all fish, levels were considered to be low (< 10 per fish).

3.4 Rainbow Trout 2011

An estimated 2,077 1+ rainbow trout (Seven Springs NI) were stocked into Ballinlough Fishery from March to June 2011, with batches ranging from an average of 0.52 kg to 1.53 kg. No rainbow trout ova were laid down in 2011 for Inland Fisheries Ireland (Ballina) stocking purposes.

3.5 Virological Screening of Wild Salmon Stocks 2011

In 2011, following a positive IPNV detection in one pool of five Burrishoole wild broodstock tested, it was considered prudent to cull all ova derived from wild broodstock in February 2011. A sampling programme for wild salmon kelts, wild salmon smolts and ranch salmon fry was agreed with the Marine Institute Fish Health Unit.

3.5.1 Wild Salmon Kelt Sampling 2011

Wild salmon kelts were collected from the downstream traps and sampled between 15.3.11 and 14.4.11. Scale and fin samples were taken and length, weight, sex, condition, and the presence/absence of *Anasakis* were recorded (Table 3.1). Kidney samples were placed in RNA later and frozen and a small piece of tissue was taken from the liver, spleen, kidney and pyloric caecae organs and frozen. RNA later samples were sent to the Fish Health Unit, MI Galway, for IPN testing. All fish tested negative for IPNV by real-time RT-PCR.

Table 3-1: Summary of wild salmon kelt data 2011.

	FEMALE	MALE
Number of kelts sampled	60	6
Length (cm)	50.8-74.0	53.5-59.4
Weight (kg)	0.85-2.7	0.83-1.3
Number of Fish: Condition A or B	58A, 2B	4A, 2B
Number of Fish: *Anasakis* present (low level)	59	6

During kelt sampling, some eggs were noted in the body cavity of the majority of females (Table 3.2). Two of the 60 females sampled had failed to spawn, representing 3.3% of the females sampled. Eggs were retained in the egg sacs in one fish and loose in the body cavity of the other. Overall, fish condition was good and the incidence of *Anasakis* observed was low. Some fish had been feeding; snails were observed in the gut of three kelts and an entire smolt was found in stomach of one kelt.

Table 3-2: Estimated number of ova retained in the body cavity of wild salmon kelt females sampled from downstream traps March/April 2011.

Estimated number of eggs retained in the body cavity	Number of females (N = 60)
0 – 10 eggs	47
11 – 50 eggs	7
51 – 200 eggs	4
All eggs retained	2

3.5.2 Wild Salmon Smolt Sampling 2011

Wild salmon smolts (n=113) were randomly sampled as they migrated through the downstream traps between 19.4.11 and 17.5.11. Scales were collected and length, weight, sex and incidence of parasites were recorded (Table 3.3). Kidney tissue was taken from individual fish and placed in RNA later and frozen. A small piece of tissue was also taken from the liver, spleen, heart and pyloric caecae and frozen in pools of five fish. RNA later samples were sent to the Fish Health Unit, MI Galway for IPN testing and all samples tested negative for infectious pancreatic necrosis virus (IPNV) by real-time RT-PCR.

Table 3-3: Wild Salmon Smolt Data Summary 2011.

Number of females sampled	72
Number of males sampled	41
Number of precocious males	7
Average length (cm)	14.38 cm (Range 11.0 - 17.2)
Average weight (gm)	27.93 gm (Range 12.3 - 42.8)
Condition factor	0.82 – 1.09

3.5.3 Ranch Salmon Fry Sampling 2011

Ranch salmon fry were sampled from hatchery tanks in May (n=150) and June (n=150). Samples were collected into virology tubes containing transport media, 5 fish per tube, and held in an ice box prior to transport to the Fish Health Unit, MI Galway. Following virological testing using BF2 cell lines, samples were shown to be negative for IPNV.

3.6 Acoustic Tracking Programme

3.6.1 Pilot Study 2010/11

Three acoustic temperature/depth tags (VemcoV13TP) were provided by CEFAS for a pilot study to examine behavioural differences and environmental preferences of wild and ranch adult salmon in Lough Feeagh. Three receivers (VemcoVR2W) were moored in Lough Feeagh, positioned to the North, Middle and South of the lake and downloaded monthly. One ranch and two wild female adult salmon returns were tagged in the Salmon Leap upstream trap in August 2010. Two salmon, ranch and non-native wild, moved downstream during November 2010 and were recovered in the Salmon Leap downstream traps. One wild female salmon (wild salmon 012) remained in the system and was recovered in the downstream trap as a kelt in April 2011. In figure 3.1, showing daily depth records for wild salmon 012 during December 2010, the period between 26th and 30th December, where there are no records, indicates that the fish was no longer within range of the receivers and had left the lake to spawn.

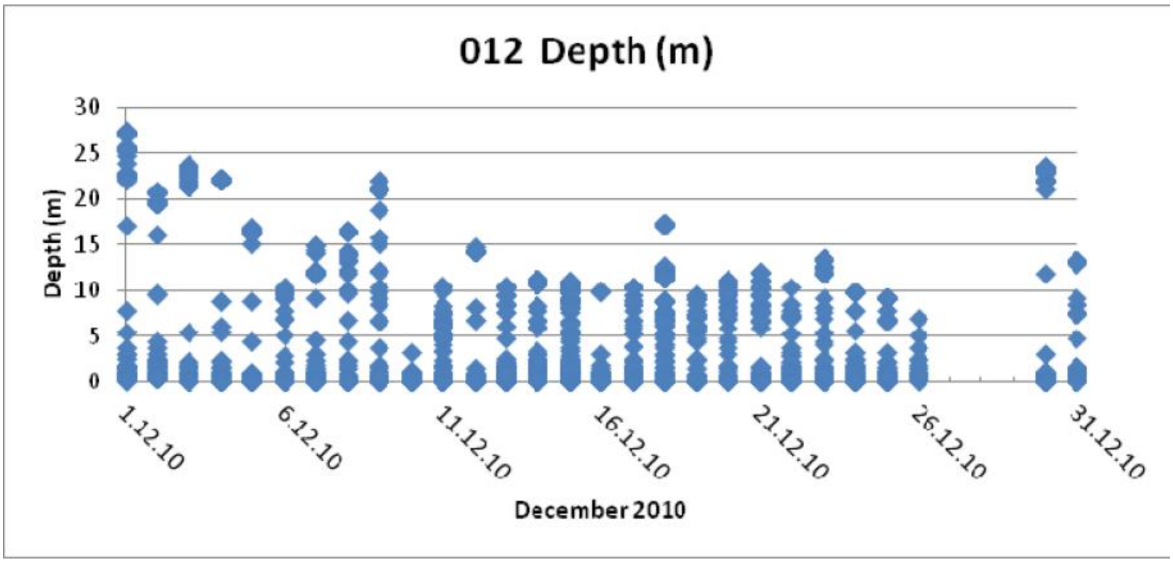


Figure 3-1: Daily depth (metres) recorded in December 2010 for wild female 'salmon 012'.

3.6.2 Tracking 2011/12

A more extensive programme commenced in 2011 whereby 11 wild and 10 ranch adult salmon were tagged with acoustic temperature/depth tags (20 Vemco V13TP, 1 Thelmabiotel ADTT-13) in the Salmon Leap upstream trap during July and August. Eight receivers were moored in Lough Feeagh, providing close to full coverage, and 2 receivers were placed in the Black and Glenamong rivers. Data should provide novel insights into fish behaviour and inform important thematic research areas 'interactions of wild and cultured salmon' and 'climate change'.

4 Wild Salmon Census Programme

The salmon census and stock assessment programme was continued in 2011 with a full upstream and downstream census of migrating wild salmon. The data provides a valuable index of salmon survivals and stock dynamics for the freshwater components of the stock.

4.1 Wild Salmon and Grilse

A total of 523 wild grilse, and 7 previously spawned grilse, were recorded moving upstream through the permanent traps during the season (Table 4.1). The upstream migration of wild salmon commenced in May. Although water levels were generally low for much of June there was an increase in the proportion of the migration in June from 0.9% in 2010 to 16.8% in 2011 (Table 4.2). The peak of the migration was in July when 43.4% of the total migration was recorded.

The main upstream grilse migration was recorded in the Salmon Leap trap with 402 grilse, compared to 121 grilse in the Mill Race trap.

The total number of spring fish recorded in the upstream traps was 50.

No wild fish were retained in the rod catch of wild grilse on Lough Furnace and therefore the total wild grilse return to freshwater was **523** and **7** previously spawned grilse.

Table 4-1: Monthly wild grilse totals for the Salmon Leap and Mill Race traps, 2011.

Month	Mill Race	Salmon Leap	Total	%
May	0	1	1	0.2
June	24	64	88	16.8
July	46	181	227	43.4
August	24	132	156	29.8
September	22	22	44	8.4
October	1	2	3	0.6
November	4	0	4	0.8
December	0	0	0	0.0
	121	402	523	100

The monthly proportion of the upstream migration of wild grilse observed in 2011 shows an earlier start to the run and a higher proportion of the run in June than has been recorded in recent years (Table 4.2). In 2010, only 0.9% of the total migration was recorded in June compared to 16.8% in 2011.

Table 4-2: Monthly proportions (%) of the wild grilse run timing 2004-2011.

	2004	2005	2006	2007	2008	2009	2010	2011
May	0.0	0.4	0.5	0.3	0.0	0.0	0.0	0.2
June	36.0	23.9	1.4	7.7	9.1	4.6	0.9	16.8
July	41.0	13.2	40.1	56.3	17.9	78.7	75.8	43.4
August	9.8	39.1	31.9	17.5	62.6	15.5	15.5	29.8
September	10.9	14.8	22.8	14.9	7.3	0.9	6.7	8.4
October	1.0	5.5	2.5	1.0	2.9	0.2	1.0	0.6
November	0.7	3.0	0.5	1.3	0.2	0.2	0.1	0.8
December	0.5	0.2	0.3	0.8	0.0	0.0	0.0	0.0

Table 4-3: Wild salmon and grilse totals in the upstream traps, 1970-2011.

Year	Total Salmon	Total Grilse
1970-74	14	1145
1975-79	36	703
1980-84	35	449
1985-89	22	492
1990-94	16	421
1995-99	12	509
1995	15	582
1996	18	409
1997	6	538
1998	4	516
1999	16	502
2000	6	568
2001	6	368
2002	2	648
2003	18	544
2004	28	580
2005	9	532
2006*	31	530
2007*	12	1049
2008	23	548
2009	37	549
2010	17	686
2011	50	523**

* years where the grilse count was raised to account for loss in the traps.

** not including 7 psg

4.2 Net marked fish in upstream traps

In 2007, the Irish Government introduced a cessation on drift netting in Irish coastal waters. The overall incidence of net marks recorded since the cessation in 2007 remains very low. Although the incidence of net marks on wild grilse showed an increase from 0.2% in 2007 to 3.8% in 2010, the incidence was lower during 2011. Net marks were only recorded on wild fish during July (2.0%) and the highest monthly percentage of net marks on reared fish was in August with 2.1% (Table 4.4).

Table 4-4: Percentage occurrence of net marks on wild and reared grilse, 2011.

	Wild Grilse	n for wild/month	Reared Grilse	n for reared/month
May	0	1	0	1
June	0	82	1.2	85
July	2.0	202	0.9	221
August	0	155	2.1	380
September	0	44	1.4	289
October	0	3	0	44
November	0	4	0	21
December	0	0	0	2
n =	491		1043	

4.3 Wild Spawning Stock

The spawning stock (escapement) represents the number of fish available for spawning. It is calculated by subtracting rod caught fish and downstream-displaced fish as well as losses due to poaching, disease and predation, which have been estimated at 5% for wild fish and 10% for reared fish.

In both 2006 & 2007, an additional number of fish, reared and wild, escaped upstream undetected (see previous reports). It is likely that the wild grilse count for those years were minimum figures and this was taken into account for all calculations based on the 2006 & 2007 spawning escapements.

4.3.1 Spawning escapement and stock

The total spawning stock in 2011 consisted of 512 wild fish and 36 reared fish (Table 4.5). The reared component was derived from 125 reared fish which were released upstream between June and September to provide an early component of reared returns for broodstock. A total of 85 reared fish were recaptured in the downstream traps prior to the spawning season and were retained as broodstock.

Table 4.6 gives the annual total spawning escapement, the wild escapement and the reared fish component. The spawning escapement of wild fish in 2007 was the highest observed over the last two decades. Particularly poor wild escapement was recorded in the 1990s and in 2001.

Table 4-5: Spawning stock of salmon and grilse, 2011.

	Wild grilse (1SW) & previously spawned grilse	Wild Salmon (2SW)	Ranched fish released upstream
Counted in trap	530	50	128
Rod Feeagh	--	--	--
Culled	10	1	0
Broodstock	0	--	0
Estimated morts.	24	--	4
Displacement	31	2	86
Spawning stock	**465**	**47**	**36**

Table 4-6: Spawning escapement, 1970-2011.

	Maximum spawning escapement	Wild fish component	Reared fish component
1970-74	1126	986	140
1975-79	725	683	42
1980-84	474	430	44
1985-89	662	428	232
1990-94	603	348	254
1995-99	519	428	95
1995	464	376	102
1996	594	355	239
1997	494	466	28
1998	498	456	42
1999	547	485	62
2000	567	527	40
2001	370	349	21
2002	570	562	8
2003	517	506	11
2004	554	528	26
2005	503	472	31
2006	552	520	32
2007	1038	958	80
2008	512	495	17
2009	517	489	28
2010	652	617	38
2011	548	512	36

4.3.2 Wild salmon broodstock stripped December 2010/2011

No wild broodstock were collected from the traps or the catchment in 2011.

4.4 Survival from Ova to Grilse

The relevant brood year for the 2011 grilse was 2007 with ova hatched in 2008 and smolt migration in 2010 (Table 4.8). As in previous years, it has been assumed for the purpose of estimating survival that ranched grilse spawned naturally. Specific data are not currently available on differential survival rates of wild and ranched stocks spawned in the wild. All relevant calculations are based on parameters set out in the Ann. Rep. No. 19, 1974.

Table 4-7: Survivals from ova to smolt and smolt to grilse.

Spawning escapement in 2007	1038
No. of females	519 - 571
Ova deposition	2,076,000 – 2,349,254
No. of smolts in traps 2010	7123
No. of smolts released	6979
Survival ova to smolt	0.34 – 0.3
No. returning grilse 2011	523
Survival smolt to grilse	7.5%
Survival to grilse per grilse female	***0.9 – 1.0***

* two estimates of the % females in the run using 50% and 55%

4.5 Ova to Smolt Survival

There was a reduction in the survival of ova to smolt from a maximum of 0.75 in 2010 to 0.34 in 2011 (Table 4.7). The ova were derived from the 2007 spawning stock the year of the cessation of the drift netting in Irish coastal waters and although the spawning escapement increased markedly in that year it did not result in an increase in smolt output. Factors such as the severe flood recorded in early July 2009, extreme low winter temperatures and density dependant factors may have had a negative impact on juvenile and subsequent smolt production.

The percentage return of grilse decreased from 8.9% to 7.5%. Although the percentage return was lower in 2011, the fact that 81% of the wild salmon smolt migration through the downstream traps was recorded over a four day period from the 19th to the 22nd of May inclusive does not appear to have had an overly adverse effect on smolt survival as has been observed in the past.

The survival to grilse per grilse female was 1.0 – 0.9 (Table 4.8).

Table 4-8: Percent survivals for ova to smolt and grilse per female grilse spawner; comparative data for 5-year averages from 1970-1989 and values for the individual brood years from 1990 onwards.

Brood year-class	% survival rates ova to smolt	survival rates to grilse per grilse female spawner
1970-74	0.48 - 0.62	1.4 - 1.7
1975-79	0.63 - 0.73	1.5 - 1.7
1980-84	0.61 - 0.69	1.7 - 1.9
1985-89	0.44 - 0.45	1.4 - 1.5
1990	0.47 - 0.54	1.8 - 2.0
1991	0.47 - 0.53	1.8 - 2.0
1992	0.48 - 0.54	1.3 - 1.5
1993	0.39 - 0.45	1.5 - 1.6
1994	0.36 - 0.41	1.3 - 1.4
1995	0.83 - 0.93	1.9 - 2.1
1996	0.53 - 0.61	1.8 - 1.9
1997	0.52 - 0.59	1.4 - 1.5
1998	0.58 - 0.60	2.4 - 2.6
1999	0.79 - 0.70	1.8 - 2.0
2000	0.56 - 0.64	1.9 - 2.1
2001	1.30 - 1.10	2.9 - 2.6
2002	0.56 - 0.64	1.7 - 1.9
2003	0.68 - 0.76	3.7 - 4.1
2004	0.53 - 0.60	1.8 - 2.0
2005	0.69 - 0.61	2.0 - 2.2
2006	0.75 - 0.67	2.4 - 2.6
2007	0.34 - 0.30	0.9 - 1.0

4.6 Wild Salmon Smolts

A total of 6629 (including 2 smolts in September) smolts were recorded in the downstream traps in 2011. The smolt migration commenced on April 2nd. The majority of the smolts, 70.5%, were recorded in the Salmon Leap trap where two main peaks were recorded one on April and a second on May 11th following periods of increased rainfall (Fig. 4.1). The main migration through the Mill Race trap occurred at the end of April during a period of reduced rainfall (Table 4.9).

Water flow conditions for downstream migration were more favourable in 2011 compared to the previous year when water levels were low for much of April and May.

The total numbers of wild salmon smolts have decreased from 7980 in 2009 to 7123 in 2010 and further to 6629 in 2011 (Table 4.10).

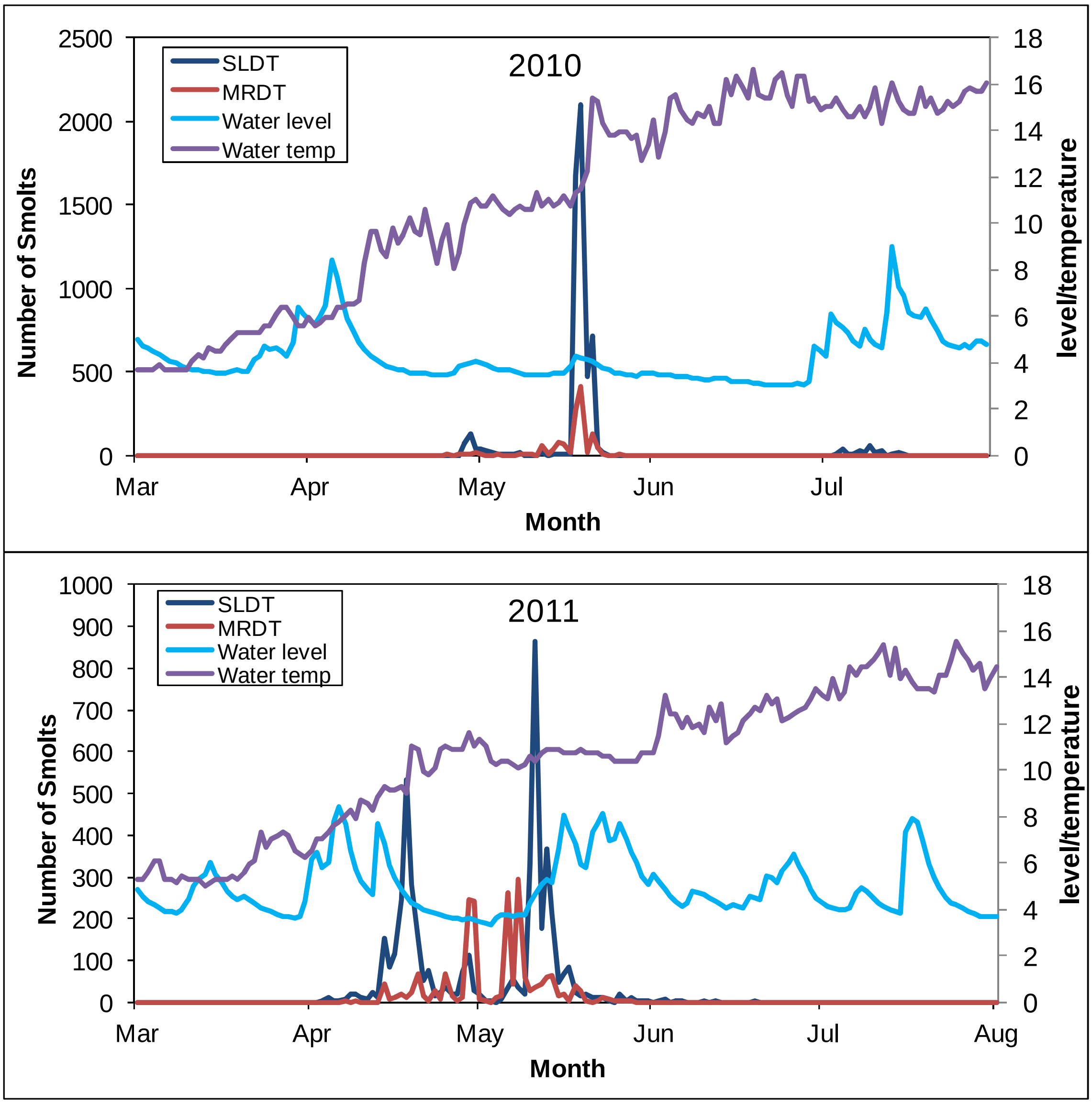


Figure 4-1: Timing of the 2010 and 2011 wild salmon smolt runs in the Salmon Leap and Mill Race traps with daily midnight water level (m x 10) and midnight temperature (⁰C). two smolts recorded in September were not shown.

Table 4-9 : Number of wild salmon smolts counted in 2011.

Month	Salmon Leap Down Trap	Mill Race Down Trap	Total
March	0	0	0
April	2156	856	3012
May	2490	1097	3587
June	27	1	28
July	0	0	0
August	0	0	0
September	0	2	2
Total	4673	1956	6629

Table 4-10: Annual numbers of wild salmon smolt recorded in the downstream traps.

Year	1990-94	1995-99	2000-04	2005-09	2006	2007	2008	2009	2010	2011
Smolts Counted	5618	7052	7490	7351	7918	6685	6909	7980	7123	6629
Smolts Released	-	6967	7340	7138	7701	6518	6691	7749	6979	6390

4.7 Wild Salmon Kelts

4.7.1 Census

Kelts migrate downstream after spawning. Water levels were low for much of March when 22.6% of the run was recorded. The highest monthly percentage of migrating salmon kelts was recorded in April when 53% of the total migration was recorded (Table 4.11).

The overall survival of kelts from the spawning stock was 35.5%, similar to the previous year of 34.2% (Table 4.12).

A total of 69 wild salmon kelts were culled from the downstream traps for IPN screening (see Section 3.5.1).

Table 4-11: Numbers of wild salmon kelts counted in 2011.

	Salmon Leap	Mill Race	Total
December '10	5	1	6
January '11	2	0	2
February	9	3	12
March	59	1	60
April	137	4	141
May	2	0	2
June	1	2	3
Total	215	11	226

4.7.2 Tagging of wild kelts

Following the cessation of drift netting during 2007 and the corresponding increase in the wild spawning stock at Burrishoole tagging of the wild kelts recommenced during 2008. A total of 148 floy tagged kelts were released from the downstream traps in 2011. During the summer of 2011 a total of 7 previously spawned grilse were recovered. They consisted of 6 which had been tagged as kelts in 2011 and one which was tagged as a kelt in 2010. The percentage recovery of PSGs for 2011 was 4.1% (Table 4.12).

Table 4-12: Comparison of annual salmon kelt runs.

Year	Kelt Quality Grade				
	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980-84	82	18	6.7	48.7	9.7
1985-89	88	21	5.1	43.2	8.4
1990-94	92	31	4.8	61.4	6.6
1995	74	28	18.3	59.9	2.3
1996	88.1	27	10.1	53.1	4.0
1997	93.7	33.5	6.3	58.9	*
1998	94.3	30.8	5.7	67.6	*
1999	90.6	38.5	4.5	76	*
2000	92.5	44.5	5.5	62.1	*
2001	97	38.5	2.8	72.5	*
2002	91.3	40.9	7.8	49.6	*
2003	95.5	37	3.5	42.3	*
2004	89.9	36.3	9	53.2	*
2005	83.3	35.5	15.3	57.6	*
2006	82.2	36.1	16	54.4	*
2007	95	37.3	4.1	**	*
2008	93.2	26.9	6.8	**	5.6
2009	96.1	20.8	3.3	44	4.9
2010	98.1	13.5	1.3	34.2	10.1
2011	95.9	22.7	0.5	35.5	4.1

* no kelt tagging

** see section 4.7 (2007 report)
A = % healthy kelts in kelt run
B = % males in kelt run
C = % lightly marked
D = % survival from wild spawning escapement
E = % recapture of previously spawned grilse in first year

5 Reared Salmon Census Programme

A programme of rearing and releasing tagged salmon has been carried out in Burrishoole since the early 1960s. The stock was based originally on donor wild salmon from the Burrishoole system and the stock has been closed since using returning tagged fish as broodstock. Additional experimental groups are sometimes released and these are freeze branded and differentially tagged so as to avoid mixing these with the core ranched stock. The ranched stock facilitates data collection and comparison with the wild stock without putting undue stress or mortality on the wild stock – in this report the ranched stock are known as reared grilse and reared 2SW salmon.

5.1 Coastal Returns

Details of coastal returns of Burrishoole fish are available in the Marine Institute 'National Report for Ireland - The 2011 Salmon Season' report.

5.2 Return rate of reared and wild grilse

A total of 1238 microtags were recovered from reared fish returning to Burrishoole in 2011. Of the total recovery 1009 were identified as Burrishoole core fish, of which 976 were grilse and 33 were 2SW fish.

The average return rate of reared Burrishoole grilse to freshwater, as determined by microtags, was similar to 2010 (2.7%) at 2.7% and had a range of 2.0 – 3.4%.

The percentage return of wild grilse decreased from 8.9% to 7.5% for the same period.

5.3 Recapture of Reared 2SW Fish

The total number of microtagged 2SW reared fish recorded in Burrishoole during 2011 was 127 comprising 5 core release groups and 2 Delphi release groups.

5.4 Smolt Releases 2011

A total of 46,279 ranched smolts were released from Burrishoole during 2011. They consisted of 32,757 smolts released as part of the on-going core ranching programme and 13,522 smolts released as two experimental groups. The experimental fish consisted of a group of 7,897 smolts (O brand) of Burrishoole multi sea winter parentage returning to Delphi and a group of 5,625 smolts (T brand) of wild Burrishoole parentage. All of the smolts were released into Lough Furnace during April. For additional information see section 3.1.1.

Table 5-1: Details of microtag codes and smolt release groups 2011.

Group ID	Tag Code	Mean Wt	Mean Length	No. Released	Date released
Core	64701	60.6	17.6	7,489	28/04/2011
Core	64702	64	17.8	7,513	28/04/2011
Core	64703	51.9	16.5	6,662	28/04/2011
B. MSW	64704	56.6	16.9	3,941	28/04/2011
B. MSW	64705	68.5	18.1	3,956	28/04/2011
Core	64706	53	16.7	5,672	28/04/2011
Wild	64707	50.1	16.1	5,625	28/04/2011
Core	54799	55.3	16.8	5,421	28/04/2011

5.5 Reared kelts

During 2010 a total of 91 reared fish were recorded in the downstream traps from a total of 133 released upstream during the summer. They included nine fish in the Mill Race trap of which five went to the holding pond and four to the broodstock pond and 74 fish in the Salmon Leap, three of which went to the holding pond and 71 to the broodstock pond. A further 13 were recorded in 2011 as kelts. The total recovery from the 133 reared fish released upstream in 2010 was, therefore, 104 fish (78.2% of those released up).

In 2011 a total of 125 ranched fish were released upstream into Lough Feeagh. Between July and December 85 (68%) of the fish released up were recaptured in the downstream traps the majority of which were retained as broodstock in the Smolt Unit. During 2012 a further 21 ranched fish were recorded as kelts in the downstream traps. Therefore the total recovery of ranched fish released upstream in 2011 was 106 (84.8%) of the 125 fish.

6 Wild Sea Trout Census Programme

The sea trout research and monitoring programmes were continued in 2011.

6.1 Upstream Movements: Timing and Numbers.

A total of 68 wild silvered sea trout and a further 87 non-silvered trout migrated upstream through the traps in 2011. Of the silvered trout, 18 were adults and 50 (73.5%) were finnock. The numbers are compared with other years in Table 6.1. Of the total run of migratory trout (155), 56% were unsilvered. For the purposes of this report, the unsilvered trout are not included with the sea trout. Table 6.1 shows that the numbers of sea trout have not recovered in the Burrishoole system and have shown a ten-fold drop since the 1970s.

Table 6-1: Annual runs of sea trout recorded in the traps.

Year	Mill Race	Salmon Leap	Total	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	72	206	
1995-99	86	91	177	
2000-04	32	64	97	
2005-09	21	44	65	
2000	33	78	111	
2001	31	58	89	
2002	26	89	115	
2003	45	33	78	
2004	26	64	90	
2005	5	10	15	
2006	16	22	38	
2007	35	59	94	
2008	4	36	40	
2009	45	93	138	
2010	10	62	72	
2011	15	53	68	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

The timing of the sea trout run in 2011, and in previous years, expressed in monthly percentages, is given in Table 6.2. The highest proportion of sea trout, both finnock and adults, moved upstream in August. There was a small movement upstream of what appeared to be smolts (9) in April. The unsilvered trout moved upstream throughout the year with 37% moving in November.

Table 6-2: Timing of the Burrishoole (a) silvered sea trout run and (b) unsilvered trout run (in monthly percentages). (n = no. of trout).

(a) Silvered Trout

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04 (483)	2005-'09 (325)	2008 (40)	2009 (138)	2010 (72)	2011 (68)
May	-	0.2	0.5	0.1	3.1	2.0	1.3	0.0	0.0	0.0	13.2
June	13.1	24.6	9.4	8.4	8.6	16.7	9.0	0.0	2.2	0.0	0.0
July	54.4	44.9	62.2	55.0	42.4	37.5	32.5	10.0	88.4	85.9	16.2
Aug	15.8	10.3	18.4	16.5	19.3	26.4	38.1	82.5	6.5	8.5	35.3
Sept	7.6	14.8	3.7	8.5	9.8	5.7	13.6	5.0	0.7	5.6	22.1
Oct	6.4	3.5	4.1	7.9	12.2	10.2	4.7	2.5	2.2	0.0	7.4
Nov	2.4	1.5	1.5	2.9	4.3	1.5	0.7	0.0	0.0	0.0	5.9
Dec	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0

(b) Unsilvered Trout

	2005 (86)	2006 (61)	2007 (94)	2008 (76)	2009 (91)	2010 (104)	2011 (87)
April	0	0	2.2	2.6	2.2	0.0	3.4
May	4.7	16.4	5.4	3.9	5.6	1.0	5.7
June	10.5	9.8	19.4	13.2	8.9	0.0	3.4
July	4.7	16.4	25.8	21.1	23.3	44.2	12.6
Aug	43	11.5	4.3	31.6	12.2	16.3	14.9
Sept	12.8	13.1	6.5	7.9	7.8	17.3	11.5
Oct	9.3	27.9	7.5	9.2	24.4	7.7	11.5
Nov	10.5	3.3	20.4	2.6	14.4	11.5	36.8
Dec	4.7	1.6	8.6	7.9	1.1	1.9	0.0

6.2 Spawning Escapement

With the continuation of the catch and release bye-law into the 2011 fishing season, no sea trout were reported killed by anglers on L. Feeagh in 2011. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 155, of which 87 were non-silvered sea trout.

Table 6-3: Annual spawning escapement of sea trout into freshwater, 1970-2011.

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04	2005-'09	2008	2009	2010	2011
Max. Escap.	2090	1146	906	231	289	156	146	116	228	175	155
Revised	1622										

6.3 Downstream Movements, Sea Trout Smolts

The 2011 smolt run amounted to 620 smolts, of which 617 were released downstream to the wild (Table 6.4). Few smolts were recorded from January to March. The main migration occurred in April and May and was strongly regulated by both water level and water temperature (Fig. 6.1). The 2011 smolt run, while still low, was much improved compared to 2010 and similar to 2009 (Table 6.5).

Table 6-4: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

Month	Salmon Leap	Mill Race	Total	%
January	0	0	0	0.0
February	8	0	8	1.3
March	15	0	15	2.4
April	350	19	369	59.5
May	203	21	224	36.1
June	2	0	2	0.3
July	2	0	2	0.3
Total	580	40	620	
Number Released Downstream			617	

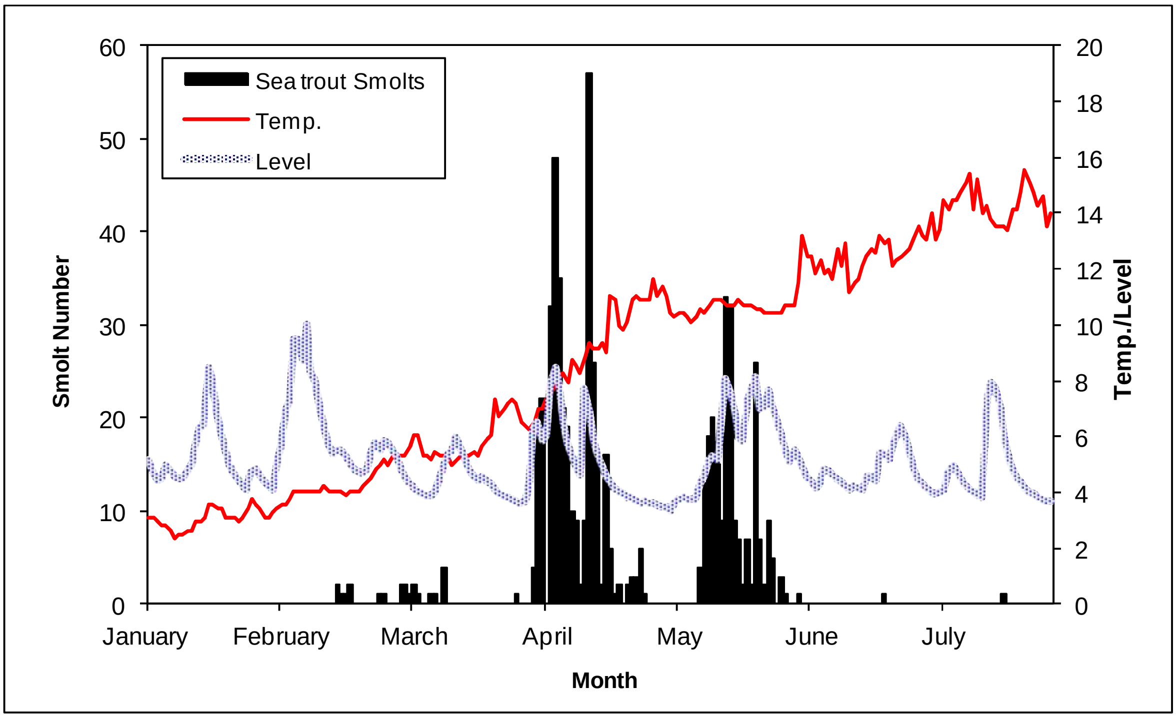


Figure 6-1: Timing of the 2011 wild sea trout smolt migration with daily midnight water level (m x 10) and midnight temperature (^{0}C).

Table 6-5: Annual sea trout smolt numbers in Burrishoole for 1970 to 2011.

	1970-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2008	2009	2010	2011
Number	4176	4038	4119	1531	1361	816	609	393	657	213	620

A total of 547 wild smolts were measured in 2011. Length measurements were taken to facilitate an estimated age breakdown of the smolt run. The estimated statistics for the 2011 smolts were a mean length of 20.3 cm and a range from 12.0 to 27.8 cm and the length frequency is presented in Figure 6.2. This gave an estimated age of 70.8% 2 year old and 33.3% 3 year olds.

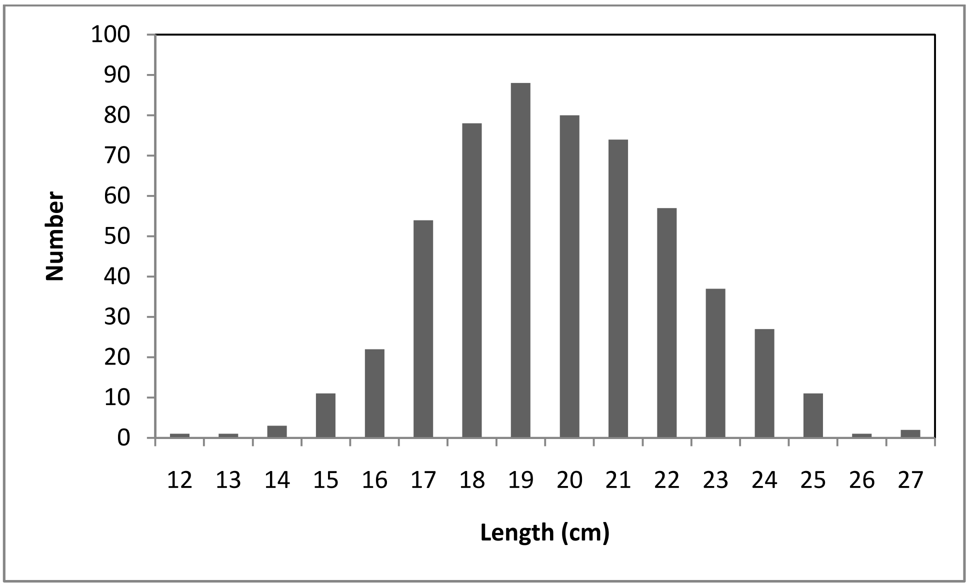


Figure 6-2: Length distribution for smolts in the Burrishoole system, 2011 (n=547).

6.4 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock being displaced downstream. It is known through mark-recapture studies that a proportion of the 1+ autumn trout do return the following year as silvered finnock. These runs of trout would appear to becoming more prolonged with substantial numbers of un-silvered 0+ and 1+ trout continuing to migrate downstream in the early months of the year.

A total of 790 trout entered the traps between July and December 2011 and up to May 2012 (Table 6.6). The percentage of 0+ trout that migrated over the period was 37.6% (Table 6.7).

Table 6-6: Numbers of migrating autumn juvenile trout in 2011, to the end of May 2012.

	0+		1+		Total	
Month	Salmon Leap	Mill Race	Salmon Leap	Mill Race	Salmon Leap	Mill Race
July	0	0	5	0	5	0
August	8	1	14	1	22	2
September	68	5	119	13	187	18
October	66	8	103	0	169	8
November	62	6	60	2	122	8
December	23	2	93	10	116	12
January '12	24	2	40	8	64	10
February '12	10	1	14	1	24	2
March '12	4	1	1	2	5	3
April '12	1	0	5	0	6	0
May '12	5	0	2	0	7	0
Total	271	26	456	37	727	63
Overall Total	297		493		790	

Table 6-7: Percentage of 0+ juvenile trout in the trapped autumn migrating trout.

Year	% 0+	Year	% 0+
1982	50.0	1997	18.7
1983	N/A	1998	33.5
1984	55.8	1999	42.0
1985	30.3	2000	47.8
1986	16.1	2001	56.3
1987	35.3	2002	32.8
1988	60.9	2003	48.9
1989	37.2	2004	35.5
1990	35.2	2005	37.3
1991	26.0	2006	51.2
1992	38.2	2007	27.9
1993	27.6	2008	28.2
1994	16.8	2009	25.0
1995	25.3	2010	34.9
1996	34.0	2011	37.6

6.5 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ year olds, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known. It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus the figures for total recruitment up to this time are over-estimated (Table 6.8).

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 6.9). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts. The fate of 1+ unsilvered juveniles migrating downstream in January to May is unknown but it would seem unlikely that these will contribute to the 2 year old spring smolt migration.

Table 6-8: Estimates of total migrant trout recruitment up to 1981.

Year	Smolt Total	Autumn trout (preceding year)	Total Recruitment
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

Table 6-9: Estimates of total migrant trout recruitment from 1982.

Year	Smolt Total	1+ Autumn trout (preceding year)	Total Recruitment
1982-84	3714	1203	4917
1985-89	3706	1063	4778
1990-94	1788	399	2187
1995-99	1361	498	1860
2000	769	358	1127
2001	530	218	748
2002	1272	910	2100
2003	787	976	1763
2004	723	426	1149
2005	777	590	1367
2006	628	251	879
2007	593	377	970
2008	393	534	927
2009	657	495	1152
2010	213	267	480
2011	620	501	1121

6.6 Marine Survival

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock in the same year historically ranged from 11.4% to 32.4% (Fig. 6.3). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's rising to 16.7% in 1999, 18.1% in 2009 and 17.5% in 2010 – the highest return rates since 1986. These increases were not, however, always sustained in subsequent years and there was a collapse in 2005 down to 1.5%. This was associated with the heaviest infestations of sea lice observed in the Burrishoole area since 1992. The return in 2011 fell to 8.1%.

The total survival of smolts to their first return to freshwater as finnock in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills *et al*, 1990)) also shows a drop in survival from 1987 to 1989 (Fig. 6.4).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.1% for the 1993 year class of smolts. There was a further increase in 1994 to 18.2% but a drop in 1995 to 8.1%. There were marginal improvements again in 1996 (12.8%) and 1997 (13.3%), a drop to 8.3% in the 1998 year class and a marked improvement in the 1999 year class where marine survival was 20%, the highest recorded in 12 years and back within the pre-collapse historical range. Total survival increased for the 2009 cohort to the highest recorded level since 1988 of 23% and to 25.1% for the 2010 cohort.

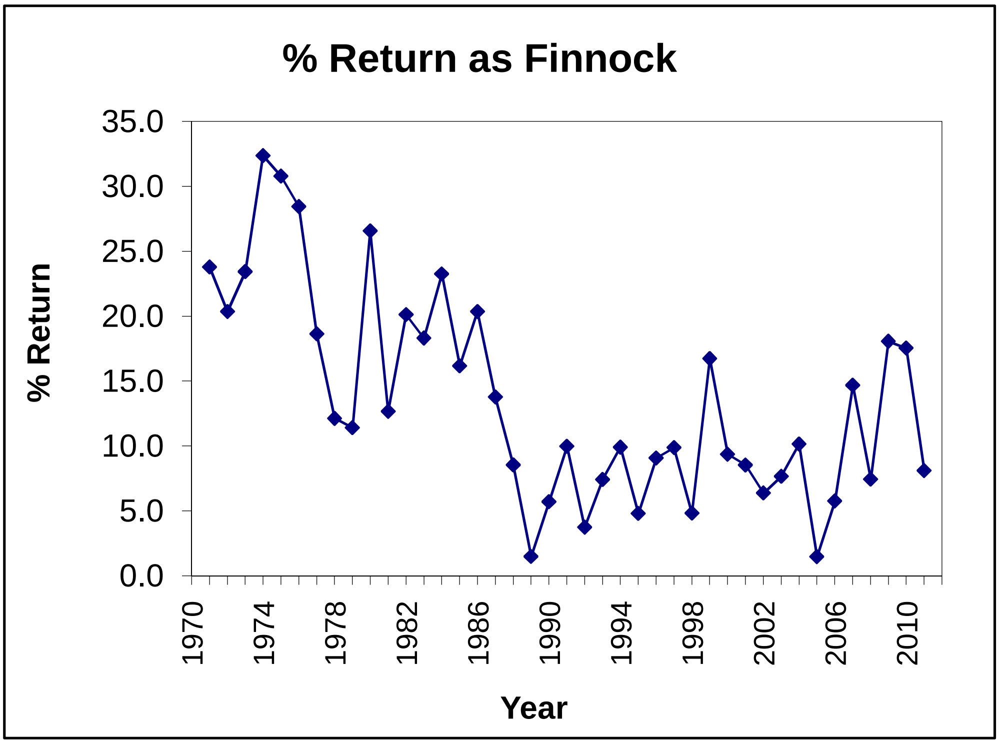


Figure 6-3: Annual percentage return of smolts returning as finnock to the Burrishoole system.

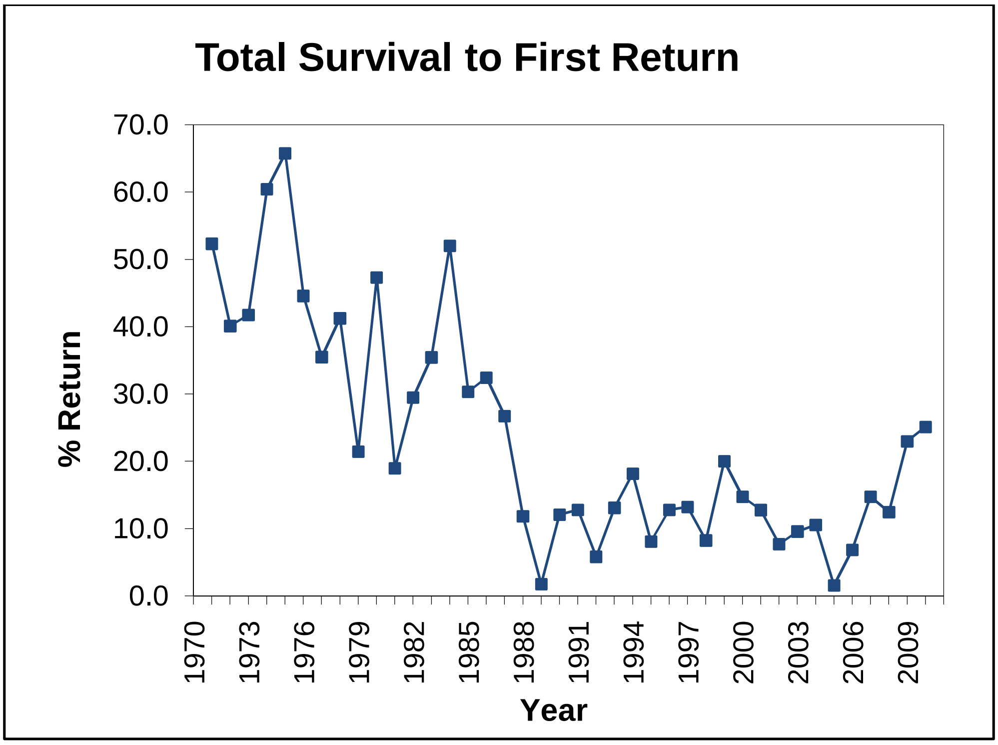


Figure 6-4: Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

6.7 Sea Trout Kelts

Table 6.10 gives the numbers of sea trout and brown trout kelts, both spawned and immature, counted downstream in the winter of 2009 and spring of 2010.

The freshwater survival of kelts is given in Table 6.11. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 6.11. In addition to the size overlap, trout counted upstream as unsilvered migrants may be counted downstream as silvered kelts, causing difficulties in making survival estimates.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may over-winter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

Kelt survival increased to 88.9% in 2010/11 and for finnock it was 108%.

Table 6-10: Timing and numbers of sea trout kelts for the 2010/2011 season.

Month	Large ST	Small ST	BT	Total ST	Total Trout
October '10	0	0	9	0	9
November	3	12	28	15	43
December	2	0	11	2	13
January '11	1	2	6	3	9
February	1	1	12	2	14
March	4	0	1	4	5
April	11	23	5	34	39
May	2	2	0	4	4
June	0	0	2	0	2
Total	24	40	74	64	138

Table 6-11: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)	Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66	1995	96.20%	“ *
1977	63	45	1996	127.70%	" *
1978	50	66	1997	97.00%	" *
1979	33	107*	1998	140.10%	" *
1980	50	82	1999	110.40%	" *
1981	44	345*	2000	70.10%	"
1982	53	203*	2001	82.00%	" *
1983	63	177*	2002	129.60%	" *
1984	74	210*	2003	66.10%	"
1985	70	98	2004	120.50%	"*
1986	66	72	2005	142.20%	"*
1987	58.7% combined		2006	110.50%	"
1988	65.50%	"	2007	228.90%	"**
1989	68.70%	"	2008	98.90%	"**
1990	79.00%	" *	2009	107.50%	"*
1991	98.70%	" *	2010	59.40%	"
1992	89.50%	" *	2011	88.90%	"*
1993	96.70%	" *			
1994	104.60%	" *			

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

7 Silver Eel Census Programme

7.1 Numbers

Silver eel trapping was continued in 2011. The main run occurred in September and October (Table 7.1). Half of the run was complete by the end of September and the run dropped off in November with only eleven eels recorded in December. Figure 7.1 shows the daily counts of silver eels.

The total run amounted to 1969 eels. As in other years, the highest proportion of the total catch (92%) was made in the Salmon Leap trap.

Table 7-1: Timing and numbers of the 2011 silver eel run.

	Salmon Leap	Mill Race	Total	%
June	14	0	14	0.7
July	112	16	128	6.5
August	141	3	144	7.3
September	652	30	682	34.6
October	746	95	841	42.7
November	137	9	146	7.4
December	11	0	11	0.6
Jan. 2012	2	0	2	0.1
Feb. 2012	1	0	1	0.1
Total	1816	153	1969	

7.2 Size

Sampling of individual eels (n = 1835) gave an average length of 44.6cm (range: 29.9 – 105.3cm) and an average weight of 179.9g (Table 7.2). The eel of 105.3cm length was the longest recorded in the period 1985 to 2011. The length frequency distribution is presented in Figure 7.2 along with those for 2009 and 2010 for comparison.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4,400, fell to 2,200 between 1983 and 1989 and increased again to above 3,000 in the '90s (Fig. 7.3). There was an above average count in 1995, possibly contributed to by the exceptionally warm summer. The count in 2001 of 3875 eel was the second highest recorded since 1982. The average weight of the eels in the samples has been steadily increasing from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Fig. 7.3). The annual count and average weight in 2010 and 2011 were both below the mean for the last decade.

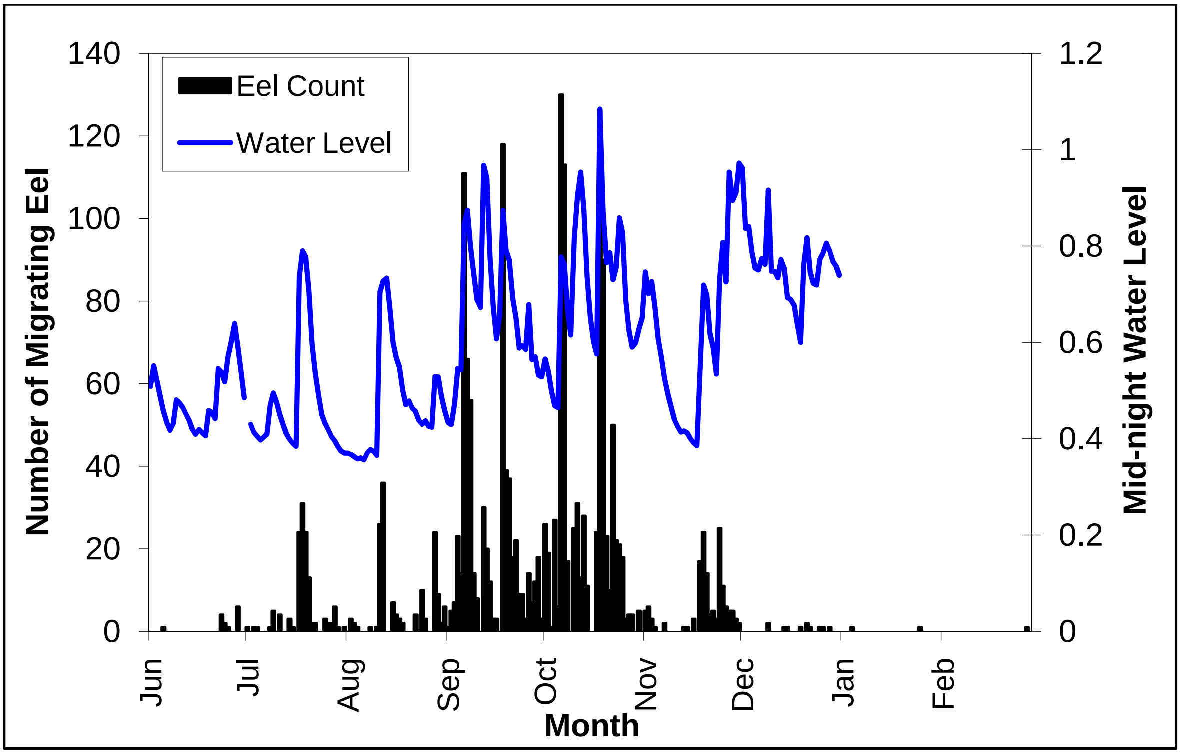


Figure 7-1: Daily counts of downstream migrating silver eel and mid-night water levels (m).

Table 7-2: Comparative data for the silver eel runs since 1971.

Years	Number Sampled	Mean. Weight (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1991 - '95	3441	227
1996 - '00	3958	212
2001	850	238
2002	732	207
2003	650	177
2004	382	216
2005	587	237
2006	493	225
2007	571	201
2008	796	234
2009	220	209
2010	982	192
2011	1835	180

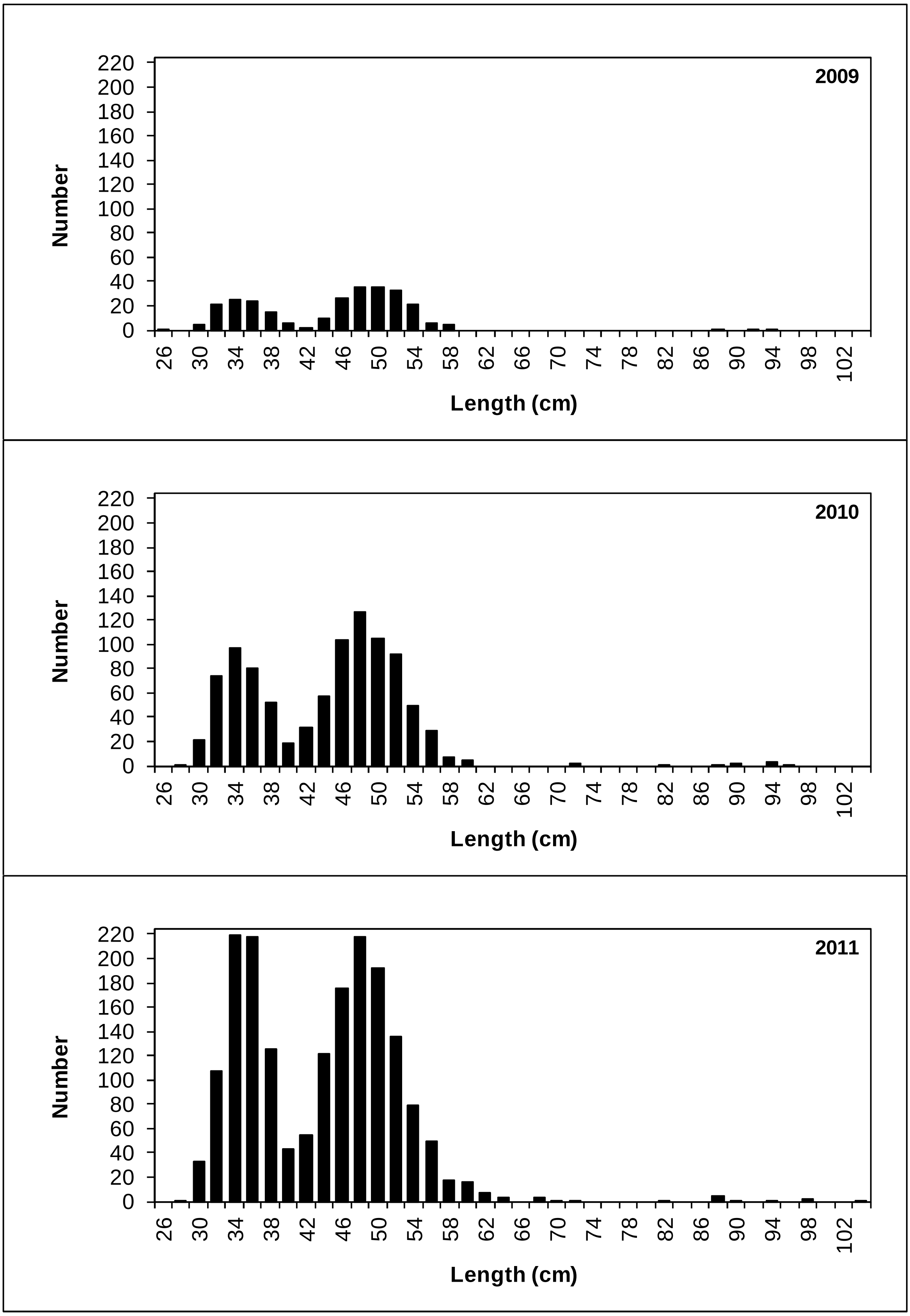


Figure 7-2: Length frequency of sub-samples of silver eels trapped in the downstream traps, 2009 (n=273), 2010 (n=960) and 2011 (n = 1835).

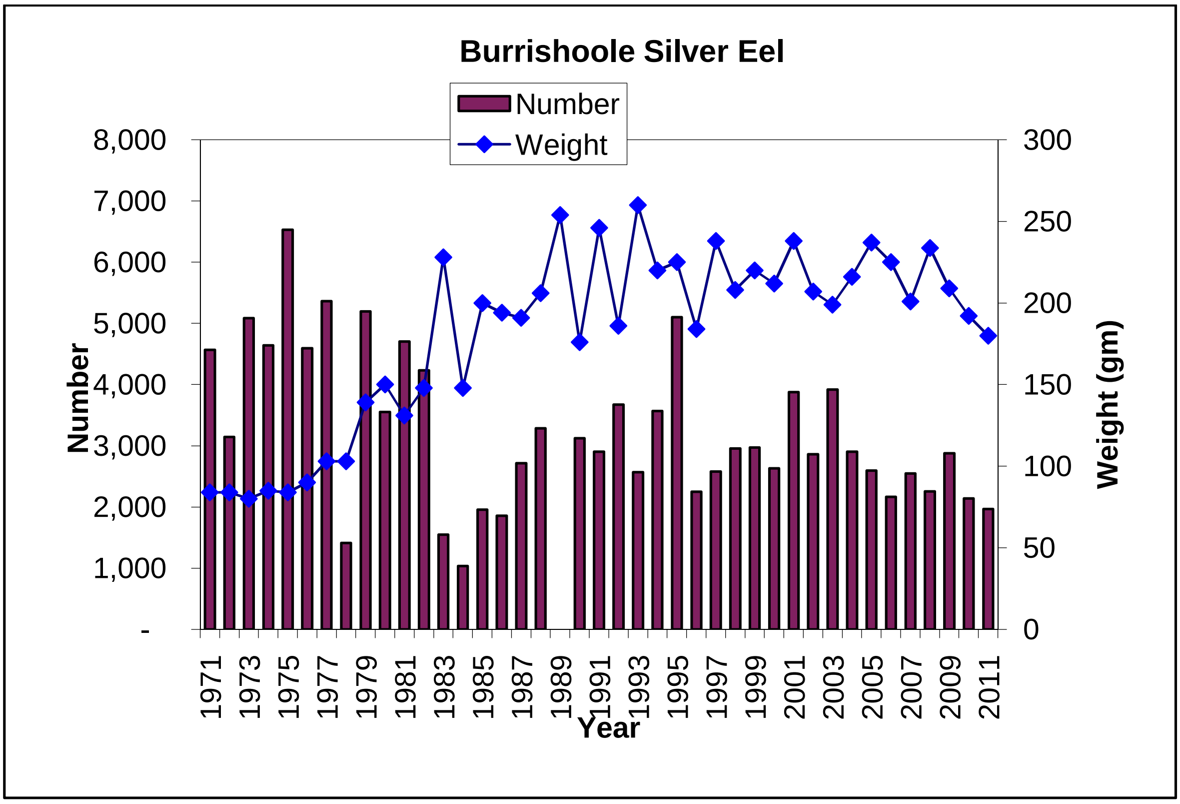


Figure 7-3: Annual number and mean weight of silver eels trapped in the downstream traps.

8 Fishery Report - Catch Data

The Burrishoole Fishery is a valuable part of the overall stock census programme and is run as an integral part of the monitoring programme. As part of the conservation of the Burrishoole wild stock, changes to the active season and to the parts of the catchment being fished have caused differences, or gaps, in the data being collected. Lough Feeagh, which had been closed to angling since 1997 for conservation reasons was opened to angling for the month of September in 2008, on a catch and release basis for wild fish. During 2009, 2010 and 2011 Lough Feeagh was open for angling on a catch and release basis from August to the end of September.

During 2011 Lough Furnace was open to angling from 22nd of July to the 25th September and Lough Feeagh from August 8th to September 30th. The fishery was operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild fish.

8.1 Numbers and Average weight of Rod Catch

The catch of both wild and ranched fish continued to increase in recent years. The wild catch increased from 26 fish in 2010 to 36 in 2011 and for the same period the reared catch increased from 79 to 86.

The Lough Furnace catch consisted of 23 wild fish and 85 reared fish and the Lough Feeagh catch of 13 wild fish and 1 reared fish.

The average weight of reared fish was 1.8kg (n = 85) and the heaviest fish was 3.1kg. No lengths or weights are available for wild fish due to catch & release being in place.

A total of 56 sea trout were caught on Lough Furnace and 1 sea trout on Lough Feeagh. Regulations remained in place whereby all rod caught sea trout were returned alive.

In addition to the sea trout caught on Lough Feeagh, a total of 222 brown trout were also caught.

8.2 Timing of Catch and Rod Effort

Rod effort on Lough Furnace was similar in 2011 to that in 2010 and was slightly higher in 2011 on L. Feeagh. The wild fish were caught mainly in July, but also in June and August on Furnace and in August and September on Feeagh. The reared fish were caught on Furnace mainly in June and July and also August reflecting a more normal timing of wild grilse return. The early catch in June of ranched fish was somewhat unusual.

Table 8-1: Wild and reared salmon rod catch and rod effort (hours) for the 2011 season for L. Furnace and L. Feeagh.

Furnace

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	5	25	187.5
July	11	37	603.5
August	6	21	444.5
September	1	2	40
Total	23	85	1275.5

Feeagh

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	0	0
July	0	0	0
August	6	0	85
September	7	1	21
Total	13	1	106

8.3 Exploitation Rates of Rod Fishery

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2. From 1997 onwards Lough Feeagh was closed to angling. Exploitation rates are only available for Lough Furnace since 1997. The cessation of angling on Lough Feeagh was due to the continuing low stock level of wild fish. Following the cessation of drift netting in 2007 and the increased return of wild fish it was decided to re-open Lough Feeagh in 2008 to angling for the month of September only on a catch and release basis for both wild and ranched fish. Since 2008, and in future years, the running of a fishery on L. Feeagh was reviewed each year and was dependent on sufficient wild stock being present.

No sea trout angling was permitted on L. Feeagh since 1997.

Anglers fishing on Lough Furnace were requested to return wild fish alive to the water. Injured or damaged wild fish were permitted to be retained; therefore, the rod catch on Lough Furnace consists of a total catch which includes released fish and a retained catch which are fish that have been killed.

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2.

Table 8-2: Rod fishing exploitation rates (2002-2011).

	2003	2004	2005	2006	2007	2008	2009	2010	2011
WILD SALMON									
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	*	531	585	691	516
Total rod catch						18	5	8	13
Rod catch retained						0	0	0	0
Angling success %[1]						3	0.85	1.15	2.5
Exploitation rate %[2]						0	0	0	0
WILD SALMON	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Loughs Feeagh & Furnace									
Total stock of wild fish	565	610	542	566	1063	572	587	703	571
+ 10% addition for									
L. Furnace population	622	671	596	623	1169	629	646	773	628
Total catch of wild fish	37	10	27	48	26	52	12	26	36
Rod catch retained	3	2	1	5	2	1	1	0	0
Max. angling success %	6.5	1.6	5.0	8.5	2.4	9.1	2	3.7	6.3
Min. exploitation rate	0.5	0.3	0.2	0.9	0.2	0.2	0.2	0	0
Max. exploitation rate	0.5	0.3	0.2	0.8	0.2	0.2	0.2	0	0
REARED SALMON	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	*	98	115	130	125
Total rod catch						1	1	1	1
Rod catch retained						0	0	0	0
Angling success %[1]						1.0	0.9	0.8	0.8
Exploitation rate %[2]						0.0	0	0	0
Loughs Feeagh & Furnace									
Total stock	1178	902	952	954	2624	1865	456	940	1293
Total rod catch	22	64	28	66	169	116	7	79	86
Exploitation rate %	1.9	7.1	2.9	6.9	6.4	6.2	1.7	8.4	6.7
WILD SEA TROUT	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	*	39	135	71	55
Rod catch						3	12	1	1
Exploitation rate %						0	0	0	0

8.4 Angling Success

Table 8.3 presents the Catch per unit effort (CPUE) which is the number of fish caught per rod day, and the Effort per unit catch (EUPC) which is the number of rod days it takes to catch a fish.

Table 8-3: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery based on a eight hour fishing day. Salmon includes both wild and reared.

	Lough Furnace				Lough Feeagh			
	Salmon		Sea Trout		Salmon		Sea Trout	
Year	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
'80-'84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
'85-'89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
'90-'95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
'96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90
'97	0.17	6.00	0.10	9.60	*	*	*	*
'98	0.44	2.30	0.08	13.20	*	*	*	*
'99	0.09	10.80	0.05	20.80	*	*	*	*
'00	0.30	3.31	0.06	16.50	*	*	*	*
‘01	0.15	6.70	0.12	8.40	*	*	*	*
’02	0.12	8.30	0.07	15.30	*	*	*	*
’03	0.13	7.60	0.06	17.70	*	*	*	*
’04	0.22	4.60	0.16	6.30	*	*	*	*
’05	0.26	3.80	0.08	13.00	*	*	*	*
’06	0.44	2.30	0.04	23.50	*	*	*	*
’07	0.49	2.10	0.14	6.90	*	*	*	*
’08	0.35	2.89	0.05	21.60	0.46	2.18	0.07	13.80
’09	0.18	5.66	0.24	4.09	0.21	4.75	0.42	2.38
’10	0.60	1.66	0.14	7.27	0.82	1.22	0.09	11.00
'11	0.68	1.47	0.35	2.8	1.06	0.95	0.08	13.1

9 Collaborative Research Programmes

9.1 National University of Galway: Molecular biology of the Atlantic salmon

This research, funded by HEA PRTLI (2003-2006), aimed to characterise gene expression profiles during the key life stages of Atlantic salmon, particularly smoltification and maturation, using functional genomics tools. In partnership with the Molecular Biology Group, National University of Ireland Galway, MI Newport provided materials and services in support of this programme. Postgraduate research theses include:

Samantha L. White 'Examination of novel differentially expressed transcripts of the neuro-endocrine system of Atlantic salmon (*S. salar*) during the parr-smolt transformation' Ph.D. November 2008.

Patrick F Forde 'Differential expression in the head kidney and spleen during the parr-smolt transformation of Atlantic salmon (*S. salar*)' Ph.D. September 2011

Aoife Guiry 'Gene expression during sexual maturation in the Atlantic salmon (*S. salar*)' Ph.D. February 2011

9.2 Beaufort Fish Population Genetics

MI Newport is committed to supporting a number of agreed projects that are facilitated and undertaken as part of the Beaufort Fish Population Genetics Programme. The Marine Research Award in Fish Population Genetics was granted by the former Department of Communications, Marine and Natural Resources to University College Cork and Queens University Belfast in June 2007. Management of the Beaufort Research Awards is the responsibility of the Marine Institute.

A series of work programmes are in progress in the Rough river, which aim to determine the scale of biologically important local adaptation at small geographical scales, in Atlantic salmon and brown trout, using a common garden experimental approach:

i. 2008/9 broodstock - To assess the importance of local adaptation at small geographical scales by comparing the relative fitness of the progeny of Burrishoole and Owenmore Atlantic salmon parents and their reciprocal hybrids in a common natural environment (Partners: MI Newport , Beaufort Ph.D. studentship UCC).

ii. 2009/10 broodstock - The establishment of a common garden experiment in the Srahrevagh (Burrishoole) and Tawnyard (Erriff) experimental rivers for the study of local adaptation in Atlantic salmon (Partners: MI Newport, WRFB, Beaufort).

iii. 2009/10 broodstock - To assess the importance of local adaptation at small geographical scales by comparing the relative fitness of the progeny of Burrishoole and Bunavela brown trout parents and their reciprocal hybrids in a common natural environment (Partners: MI Newport, Beaufort)

Trapping facilities on the Rough River were serviced on a daily basis and fish in the downstream traps were recorded and sampled according to protocol. Salmon smolts (2+) collected in Spring 2011 marked the end of the freshwater component for study (i) and genotyping and assignment of fish samples is ongoing.

Sarah Healy (2010). 'A river specific juvenile Atlantic Salmon growth model for the Srahrevagh river, West of Ireland: Potential for life history changes in response to projected increases in water temperature' submitted as part of an M.Sc Marine Biology University College Cork. M.Sc thesis 2010.

9.3 Prevent Escape

The Prevent Escape project (2009-2012) is a research project funded by the European Community under FP7. Escapes of fish from sea-cages have been reported for almost all major species cultured across Europe, including Atlantic salmon, sea bream, sea bass, Atlantic cod and rainbow trout. The project is specifically designed to conduct and integrate biological and technological research on a pan-European scale to improve recommendations and guidelines for aquaculture technologies and operational strategies that reduce escape events. Prevent Escape involves 11 partners from six countries (Norway, Greece, Spain, Malta, Scotland and Ireland) and is led by SINTEF Fisheries and Aquaculture. The Marine Institute are involved in two work packages and as project leaders for Map Escape, are responsible for carrying out a Europe wide survey of escape events and their causes.

9.4 SALSEA

The Marine Institute is one of 20 partners from 9 countries involved in a three year research programme (2008-2011) 'Advancing understanding of Atlantic Salmon at Sea: Merging Genetics and Ecology to Resolve Stock-specific Migration and Distribution patterns', funded by the European Community under FP7. In June/July 2009 over 800 post-smolts were taken in three surveys, carried out by scientists from Ireland, the Faroe Islands and Norway. Over 1,700 contemporary samples have been taken from the surveys in 2008 and 2009 and these will be tested for a broad range of genetic and biological parameters. A wealth of other biological material and oceanographic data was also collected. A full update on the work of SALSEA merge is available on http://www.nasco.int/sas/salseamerge_documents.htm

9.5 Lakes Studies

Palaeolimnological assessment of recent ecosystem disturbance / regime shifts in sediment cores from ecotonal brackish lake systems

Filippo Cassina from Mary Immaculate College, Limerick, commenced the fourth year of his PhD Study '*Palaeolimnological assessment of recent ecosystem disturbance / regime shifts in sediment cores from ecotonal brackish lake systems*'. The aim of this EPA funded fellowship is to examine the recent palaeolimnology of two brackish lake systems, one of which is Lough Furnace. Specifically the project is quantifing the salinity and nutrient response in the fossil diatom, cladoceran and foraminifera records. These results will be supplemented by quantification of the organic isotope ratio (C:N) in the sediment record in an effort to establish changes in allochthonous and authochonous sediment inputs. Filippo expects to submit his thesis in early 2012.

Limno- and palaeo- limnological responses to lake water dissolved organic carbon (DOC)

This PhD study, funded by the EPA, is being carried out by Karin Sparber of Mary Immaculate College Limerick, under the supervision of Dr. Catherine Dalton. This project aims to provide a clearer understanding of the special features of dystrophic (nutrient poor) lake waters through quantification of the response in bacterial and algal populations of Lough Feeagh. Karin is currently in her fourth year of study, and is focussed on analysis and thesis writing. She hopes to submit her thesis in early 2012.

Estimating carbon pools and processing in a humic Irish lake.

Traditional models of production in lakes emphasise the importance of phytoplankton as a source of energy to the open-water food web. However, in humic lakes, dissolved organic carbon (DOC) from the surrounding catchment, supplying the microbial portion of the food web, may be an equal or more important source of carbon. The aim of this PhD project by Liz Ryder, Dundalk IT, is to elucidate the role of these two carbon sources in fuelling production in a humic lake in the west of Ireland. The project will use a combination of high resolution fluorescence data available for both the phytoplankton and DOC pools, together with lower frequency sampling of the carbon pools in additional biological components, to quantify carbon availability and processing. The collated data will facilitate application and validation of models of in-lake productivity and an assessment of future climate impacts on carbon cycling using downscaled climate change data which are available specifically for the study site. These data, together with data available from other past and on-going projects, will also allow comparative assessment of primary and secondary production in this lake within the framework of a whole-lake carbon budget, both under present and future climate conditions. Liz is being jointly supervised by Dr Eleanor Jennings, who has worked on data from the Burrishoole catchment for many years, and Elvira de Eyto (MI). Work in 2011 included calibration of instruments, and zooplankton experiments to assess carbon uptake. A paper on temperature quenching of DOC was published.

9.6 EU EELIAD

The FP7 funded EELIAD Programme focuses on improving our knowledge of the life history of eels both in the marine and freshwater environments. The project will assess the possible reasons for recruitment failure in eels and identify the characteristics of those eel-producing areas which produce silver eels of sufficient quality to achieve successful migration to the spawning grounds. The proposed research will facilitate the development of models that can be used by managers to identify the most effective and appropriate measures to improve the quality of silver eel escapement and contribute significantly to the objectives of the EU's Eel Recovery Plan. Silver eels and technical support were provided to the project in late 2008 and 2009 for the satellite and data storage tag tracking of silver eels in the ocean. Burrishoole eels were used as *Anguillicola* free individuals. The Marine Institute also provide technical support to EELIAD and act as a link between the project, ICES and the EU. The annual meeting of the project was held in Biarritz, France, in 2011.

9.7 SANIFAC

(from Liwen Xiao)

It was estimated that about 500,000 ha of peatland was afforested between the 1950s and 1990s in the UK and 300,000 ha in Ireland. Many of these blanket peat forests are now reaching harvestable age and concerns have been raised about the potential release of nutrients to the receiving aquatic systems as a result of harvesting. These areas contain the headwaters of rivers, many of which contain Red List species (e.g. salmonids and freshwater pearl mussels) which make them important biodiversity refuges. Despite the fact that the sensitivity of clearfelling upland peat catchments has risen to prominence in recent years in terms of economic and conservational viability, sustainable protection methods are poorly researched and proven. The objectives of this study are to investigate the impacts of forestry clearfelling on the ecology and flow regime of receiving water and to assess the performance of buffer zones, phased felling, brash removal and the novel grass seeding method on ameliorating any negative clearfelling impacts.

In order to quantify the effects on the water quality, two sub-catchments have been closely monitored in the two years pre- and post-harvesting and hydrological, physical, chemical and biological parametric data such as rainfall, stream flow rate, pH, temperature, DO, conductivities, phosphorus (P), nitrogen (N), suspended solids (SS), macroinvertebrates and diatoms have been collected intensively. The results indicated that, even with the implementation of the best management practices, peatland forest harvesting activities could (1) have no significant impact on SS concentration in the receiving water; (2) increase catchment water yield but not increase flood risk; (3) increase P and N concentrations in the study streams; and (4) affect the macro-invertebrate and diatom assemblages in the rivers.

Buffer zones (BZs) have been recommended internationally as a mitigation measure for tackling pollution sources and transport. However, large areas of upland blanket peat were afforested in the UK and Ireland before the importance of the riparian buffer areas was realized. In order to reduce the possible negative impact of harvesting activities on receiving water bodies, the creation of buffer areas along receiving water courses prior to the clear-felling of the main plantation has been proposed. In this study, a small buffer zone with the effective area of about 0.1 ha was established and seeded with native grass species and the runoff from the upstream forest with area of about 10 ha was spread to the buffer zone. One year later, the upstream forest was harvested. The result indicated that the buffer zone removed 45.3%, 33.7% and 17.6% of the suspended solid (SS), total oxidised nitrogen (TON) and PO_4-P, respectively, in the first year of harvesting.

To reduce nutrients leaching from forest catchment to water, a novel practice – grass seeding clearfelled areas immediately after harvesting – was proposed in this study. It was hypothesized that if the vegetation could quickly recover after forest harvesting, the nutrients would be retained *in situ* through vegetation uptake. A field trial was carried out to identify the successful native grass species that could grow quickly in the blanket peat forest. The two successful grass species - *Holcus lanatus* and *Agrostis capillaris* – were sown in three blanket peat forest study plots with areas of 100 m^2, 360 m^2 and 660 m^2 immediately after harvesting. Areas without grass seeding were used as controls. One year later, the P content in the above ground vegetation biomass of the three study plots were 2.83 kg P ha^{-1}, 0.65 kg P ha^{-1} and 3.07 kg P ha^{-1}, respectively, which were significantly higher than the value of 0.02 kg P ha^{-1} in the control areas. The water extractable phosphorus (WEP) in the three study plots were 8.44 mg (kg dry soil)$^{-1}$, 9.83 mg (kg dry soil)$^{-1}$ and 6.04 mg (kg dry soil)$^{-1}$, respectively, which were lower than the value of 25.72 mg (kg dry soil) $^{-1}$ in the control sites. The results indicate that grass seeding of the peatland immediately after harvesting can quickly immobilize significant amounts of P and warrants additional research as a new Best Management Practice following harvesting in the blanket peatland forest to mitigate P release.

To further examine the grass seeding practice, experimental plots with defined boundary conditions have been established. In addition, other mitigation approaches such as whole tree harvesting was also tested by using plots. In these plots, three sets of five treatments were compared as follows: 1) no brash and no seeded grass, 2) brash without seeded grass, 3) brash with seeded grass 4) seeded grass only, 5) brash removed after 6 months. The results indicated that (1) brash mat was significant nutrients release sources; (2) whole tree harvesting could significantly reduce nutrients release and (3) grass seeding could be a sustainable practice for nutrient release control after forest harvesting.

SANIFAC mainly focuses on the assessment and mitigation of soil and nutrient losses from acid-sensitive forest catchments. Dr. Michael Rodgers was the original Principal Investigator. After his retirement at the end of November 2009, Professor Padraic O'Donoghue took over the PI role. Dr.

Liwen Xiao is the project co-ordinator and research fellow. Mr. Mark O'Connor is the research assistant. Connie O'Driscoll and Zaki-ul-Zaman Asam are the two postgraduate students. The field study of this project is carried out in four sub-catchments in Burrishoole Catchment. Liwen Xiao and Zaki-ul-zaman Asam are based in NUI Galway. Mark O'Connor and Connie O'Driscoll are located in Marine Institute, Newport.

9.8 HYDROFOR

(from Mark Healy, NUIG)

HYDROFOR is funded by the Environmental Protection Agency's STRIVE fund for UCD, UCC and NUIG to work on six catchments (3 in higher details than others) for 5 years commencing on 1/5/2008 and will end on 30/4/2013. The NUIG component of the work is based in Newport.

Dr. Mark Healy is the project co-ordinator. Mr. Mark O'Connor is the research assistant (funded through SANIFAC). John Regan is a Research Assistant and Joanne Finnegan is the postgraduate student. The field study of this project is carried out in two sub-catchments in the Burrishoole Catchment. Mark Healy, John Regan and Joanne Finnegan are based in NUI Galway and make regular visits to Burrishoole. Mark O'Connor is located in Marine Institute, Newport.

The HYDROFOR project aims to compare nutrient and sediment release from forest clearfelling operations. Two sites are being examined: (1) in Glenamong, sediment and nutrient release from two 8-ha sites (a study site and a control site) are being examined; (2) in Altahoney, the effectiveness of naturally revegetated riparian buffer zones - clearfelled in 2006 – in mitigating the particulate and nutrient releases from forest harvesting activities upslope (which took place in January/February, 2011) are also being investigated.

Progress to date

Research work in two micro-catchments, Glenamong and Altahoney, is currently being conducted by NUI Galway. This work is funded by the EPA (ref: HYDROFOR).

The Glenamong site comprises a study and a control site. Each site is fully instrumented with a H-Flume for measuring the flow and a data-sonde for measuring pH, temperature, conductivity and dissolved oxygen. Prior to and subsequent to clearfelling of the study site, which took place in January – February 2011, baseline and storm flow measurements of water volumes draining the catchment and water quality have been conducted. Suspended sediment release peaked to a daily flow weighted mean concentration of approximately 100 mg/L during clearfelling, but, following the installation of sediment traps, reduced considerably to concentrations just above the pre-clearfelling values (Appendix; Figure A1). Soluble reactive phosphorus (SRP) concentration has increased gradually subsequent to clearfelling and is currently being monitored during storm events.

The second study site is located in the Altahoney forest in the Burrishoole catchment in Co. Mayo. This catchment is situated in the Nephin Beg range at an approximate elevation of 150 m above sea level. In January-March 2011, approximately 2 ha of forest in Altahoney was clearfelled. A buffer zone - clearfelled in 2006 – is in place to capture nutrients and sediment from the clearfelled site. The site is reasonably well vegetated and is instrumented with piezometers to monitor water table changes and sampling tubes to enable subsurface water samples to be collected and analysed. Each sampling location comprises a set of 3 sampling tubes, positioned at 20 cm, 50 cm and 100-cm-depths below the surface. Water samples are collected at these points (approximately once a month). The site is also instrumented with time domain reflectrometry (TDR) probes to measure soil water content, and the standing forest and revegetated buffer areas are also instrumented with greenhouse gas measurement facilities.

In August 2011, a survey was carried out to determine the percentage survival and increase in growth of the saplings, depending on the current height and existence of the tree, to determine which tree species best suited the peatland buffer environment. Water extractable phosphorus (WEP) and desorption-sorption isotherm testing was also carried out on samples of the soil from the regenerated buffer area and the adjacent mature standing forest. For both tests, a series of sampling points were selected in three transects parallel to the river in the regenerated buffer area at the following locations: (1) 1 m from the river (2) under the brash mat approximately 35 m from the river, and (3) under a vegetated area in-between brash mats approximately 45 m from the river. Soil samples were also collected (using a completely randomized block design) from the mature standing forest to represent the contributing area.

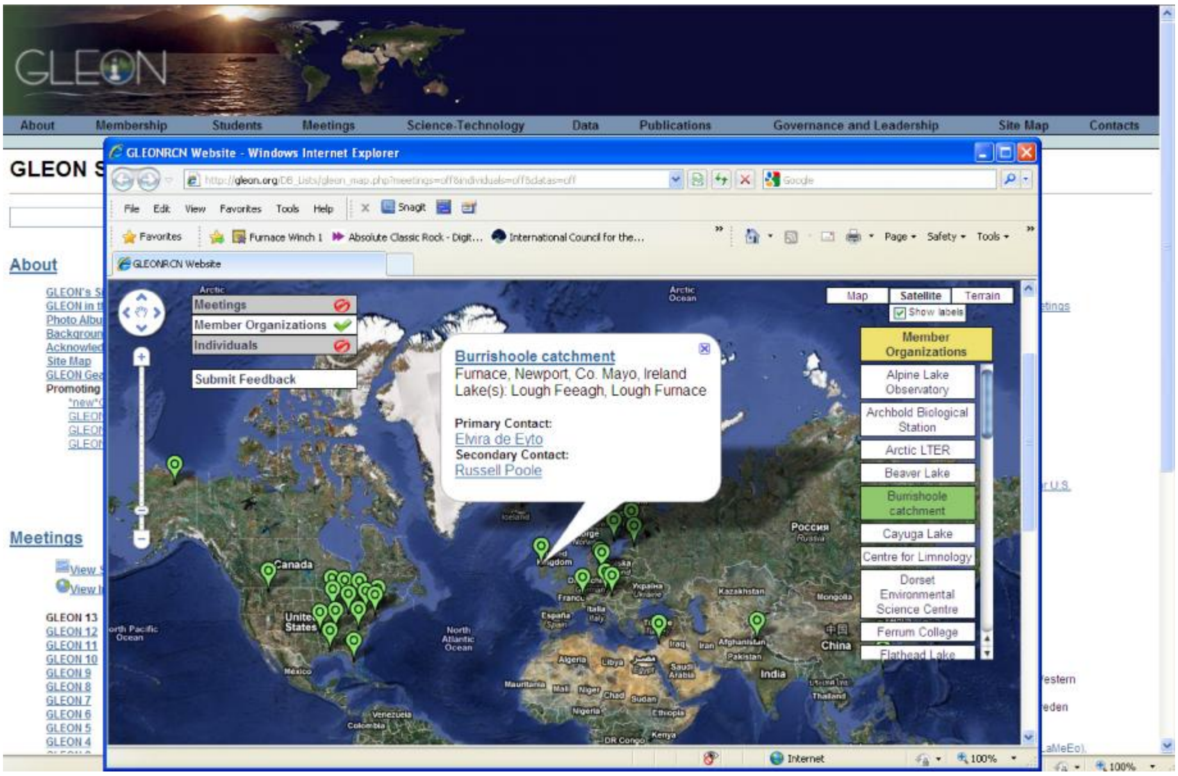
Inverse Distance Weighted (IDW) images, generated from the subsurface SRP concentrations, show the comparison of the regenerated buffer zone with the standing forest (Appendix 1; Figure A3). These illustrate the higher nutrient concentration under the decaying brash mats in the buffer zone, which were left on site five years before the present study. The SRP concentration reduces close to the river edge due to the adsorption capacity of the mineral peat layers near the river.

Future work plan

The project is going to schedule and testing is due to be complete by July/August 2012. The PhD student is due to finish in November, 2012. Water sampling is being conducted at site during flood events. The final round of WEP testing of soil samples is currently being conducted. The greenhouse gas measurement study is complete and pre- and post-clearfell data is being analysed. Two papers, one on the impact of the buffer area at Altahoney on nutrient release and a second on greenhouse gas emissions from the standing forest and buffer area, are currently being written. The PhD candidate has also presented her data at approximately 5 international and national conferences.

9.9 GLEON

The Burrishoole Catchment is now a member of GLEON – a grassroots network of limnologists, ecologists, information technology experts, and engineers who have a common goal of building a scalable, persistent network of lake ecology observatories worldwide. The GLEON network currently includes 28 major lake sites worldwide, where remote high frequency monitoring of lake ecosystems is taking place (see www.gleon.org). The Institute has been represented at the last 6 GLEON meetings by either Liz Ryder or Elvira de Eyto. Two GLEON meetings took place in 2011; GLEON12 was held in Israel in April and was attended by Elvira de Eyto and Liz Ryder (DkIT). GLEON13 was held in New Hampshire USA, and was attended by Liz Ryder (DkIT) and Mary Dillane. Both meetings were workshop based with special emphasis on lake processes, Lake Metabolism, Ecosystem modelling and data management. The Marine Institute and Dundalk IT will co-host GLEON14 in Mayo in October 2012. It is anticipated that in excess of 120 international Scientists will attend this meeting which is a wonderful testament to the work being done by the Marine Institute in this area.



9.10 Publications

Belpaire, C. Geeraerts, C. Evans, D. Ciccotti, E. & Poole, R. (2011). The European eel quality database: towards a pan-European monitoring of eel quality. Environ Monit Assess., *Environ Monit Assess* (2011) 183:273–284 DOI: 10.1007/s10661-011-1920-2

Consuegra, S., de Eyto, E., McGinnity, P., Stet, R J M. and Jordan, W C. (2011). Contrasting responses to selection in class I and class IIα major histocompatibility-linked markers in salmon. *Heredity*, 107: 143-154.

de Eyto, E., McGinnity P., Huisman, J., Coughlan, J., Consuegra, S., Farrell, K., O'Toole, C., Tufto, J., Megens, H-J., Jordan, W., Cross, T. & Stet, R.J.M. (2011). Varying disease-mediated selection at different life-history stages of Atlantic salmon in fresh water. *Evolutionary Applications*, 4 (6); 749–762.

Jackson ,D., Cotter, D., Ó Maoiléidigh, N., O'Donohoe, P., White, J., Kane, F., Kelly, S., McDermott, T., McEvoy, S., Drumm, A., Cullen, A., Rogan, G.. (2011). An evaluation of the impact of early infestation with the salmon louse Lepeophtheirus salmonis on the subsequent survival of outwardly migrating Atlantic salmon, Salmo salar L., smolts. *Aquaculture* **320**; 159–163.

King, J.L., Marnell, F., Kingston, N., Rosell, R., Boylan, P., Caffrey, J.M., FitzPatrick, Ú., Gargan, P.G., Kelly, F.L., O'Grady, M.F., Poole, R., Roche, W.K. & Cassidy, D. (2011) Ireland Red List No. 5: Amphibians, Reptiles & Freshwater Fish. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

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O'Driscoll , C., Rodgers, M., O'Connor, M., Zaki-ul-Zaman Asam, deEyto, E., Poole, R., & Xiao, L., (2011) A potential solution to mitigate phosphorus release following clearfelling in peatland forest catchments. *Water Air Soil Pollut*, 221 (1), 1-11.

O'Farrell, B., Benzie, J A H, McGinnity, P., Carlsson, J., de Eyto, E., Dillane, E., Graham, C., Coughlan, J. & Cross, T. (2011). MHC-mediated spatial distribution in brown trout (Salmo trutta) fry. *Heredity*, 108: 403-409.

Ryder, L., de Eyto, E., Gormally, M., Sheehy Skeffington, M., Dillane, M. & Poole, R. (2011). Riparian zone creation in established coniferous forests in Irish upland peat catchments: Physical, Chemical and Biological Implications. *Biology & the Environment*, 111B (1); 41-60.

10 Catchment Stock Assessment

10.1 Introduction

The Burrishoole catchment, upstream of the main fish traps, has been monitored since 1990 with surveys of the salmonid and eels stocks taking place in the rivers and the main lakes. Electrofishing, with 3 fishing depletions, is used for salmonids and eels in the streams, fine mesh beach seines are used for salmonids in the lakes and summer fyke nets are used for eels in the lakes.

10.2 Electrofishing Surveys

2010 marked the completion of 20 years of consistent electrofishing surveys in the Burrishoole and Owengarve catchments. The 2011 annual surveys of fish stocks in the Burrishoole and Owengarve rivers took place between the 5th August 2011 and the 29th September 2011. The 2011 survey was severely curtailed owing to bad weather, leading to very few days where conditions allowed electrofishing and no beach seining was possible. 22 sites were fished in total, which is approximately half of our normal index site list.

A total of 1296 fish were caught, identified and measured from the 22 sites. Summary data are presented in Figures 10.1 – 10.6, and these show the distribution of fish densities around the catchment for eel (Fig. 10.1), 0+ salmon (Fig. 10.2), 1+ salmon (Fig. 10.3), 0+ trout (Fig. 10.4), 1+ trout (Fig. 10.5) and 2+ trout (Fig. 10.6). Densities were calculated using three pass removal sampling.

Eel densities in the streams were generally below 0.02 eel per m^2.

Highest densities of 0+ salmon were recorded in the lower sites of the Srahrevagh River (below the fish trap). Absence of juvenile salmon from the Srahrevagh River between the trap and the falls was due to the trap being closed to upstream migrating spawning adults. Two sites on the Lodge River were fished for the first time in a decade, and relatively good numbers were found (0.36 and 0.40 fish/m^2). These two sites also contained relatively good quantities of 1+ salmon.

The streams entering Lough Feeagh had the highest trout densities, and all but one site contained 0+ trout.

10.3 Beach Seine Surveys

Due to high water levels and poor weather conditions, beach seine surveys were not conducted in 2011.

10.4 Fyke Net Surveys

Fyke net surveys of yellow eels have been conducted in the 1970s and 1980s as parts of previous studies. The Burrishoole lakes Feeagh and Bunaveela have been incorporated into the National Eel Survey in 2009-2011.

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year.

Fyke net surveys carried out between 1960 and 2008 will provide a useful bench mark against which to assess the changes in stock. The yellow eel monitoring strategy will rely on the use of standard fyke nets. Relative density will be established based on catch per unit (scientific-survey) effort.

Bunaveela Lough is located in the upper reaches of the catchment. It has a surface area of 42ha and a maximum depth of 23m. Bunaveela L. was fished in the traditional style in 2011 (28 July 2011), with chains of 10 nets fished at two sites (A, C). In total only two eels were caught with a catch per unit of effort of 0.07. The eels ranged in length from 38.4cm to 56.6cm.

Lough Feeagh has a surface area of 395ha and an average depth of 14.5m (with several areas >35m in depth). L. Feeagh was fished in the traditional style in 2011 (26-27 July 2011), with chains of 10 nets fished at six sites (A, C, D, E, F, J) for one night each. In total, 76 eels were caught with a catch per unit effort (CPUE) of 1.25 (Table 10.1). The eels average length was 43.2 cm and ranged in length from 29.0cm to 86.2cm, with a total weight of 13.2kgs caught for the 2 nights (Table 10.1).

Lough Furnace, the tidal lough has a surface area of 125ha north of Nixon's Island and 16ha between Nixon's Island and the mouth of the estuarine river ('Back of the House'). The main lough has a maximum depth of 21.5m. Furnace is heavily stratified with significant areas of deoxygenated water in the main basin. L. Furnace was fished in the traditional style in 2011 (20-23 July 2011), with chains of 10 nets fished at six sites (A, C, D*2, E, F, J) in one night each and one night with two chains of nets at the Back of the House.. In total, 54 eels were caught.

In L. Furnace, 35 eels were caught with a catch per unit effort (CPUE) of 0.07 (Table 10.1). The eels average length was 39.9 cm and ranged in length from 19.4cm to 86.1cm, with a total weight of 4.78kgs caught for the 2 nights (Table 10.1).

In the Back of the House, 19 eels were caught with a catch per unit effort (CPUE) of 0.95 (Table 10.1). The eels average length was 46.5 cm and ranged in length from 33.9cm to 72.5cm, with a total weight of 3.68kgs caught (Table 10.1).

A full analysis of the trends in CPUE and eel size will be presented in the 2012 report.

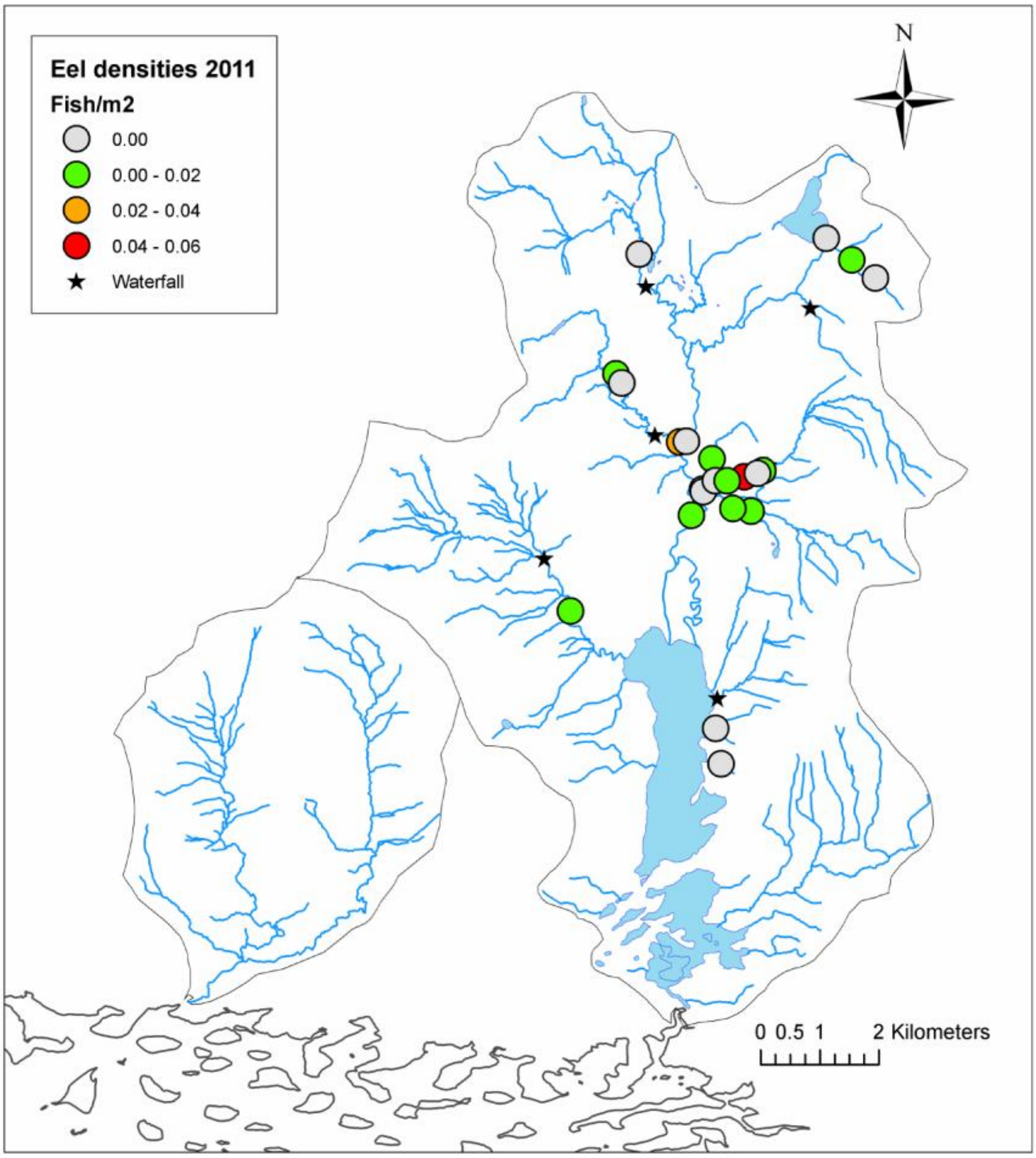

Figure 10-1: Densities of eel calculated from the 2011 electrofishing survey of the Burrishoole and Owengarve catchment.

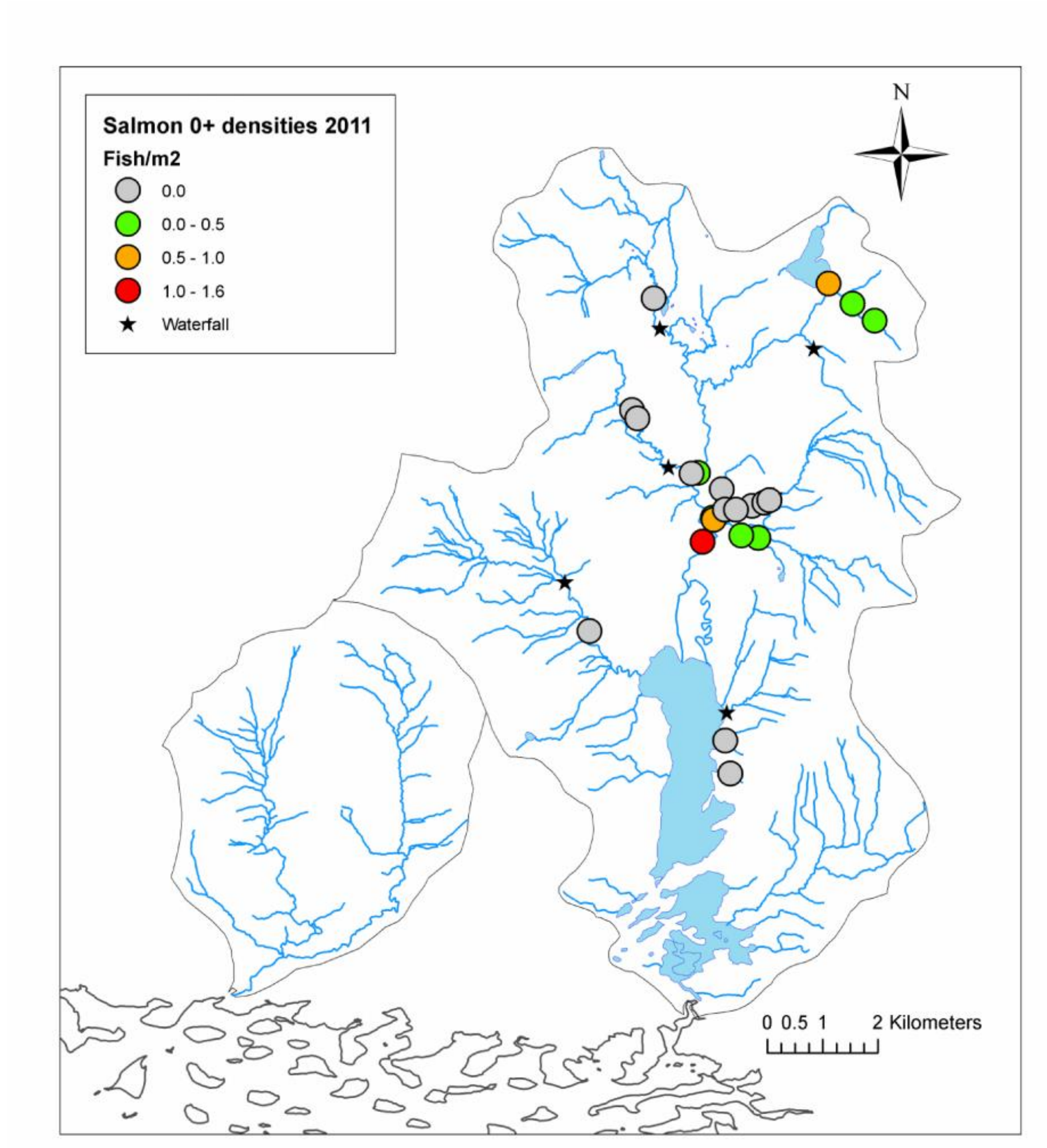

Figure 10-2: Densities of 0+ salmon calculated from the 2011 electrofishing survey of the Burrishoole and Owengarve catchment.

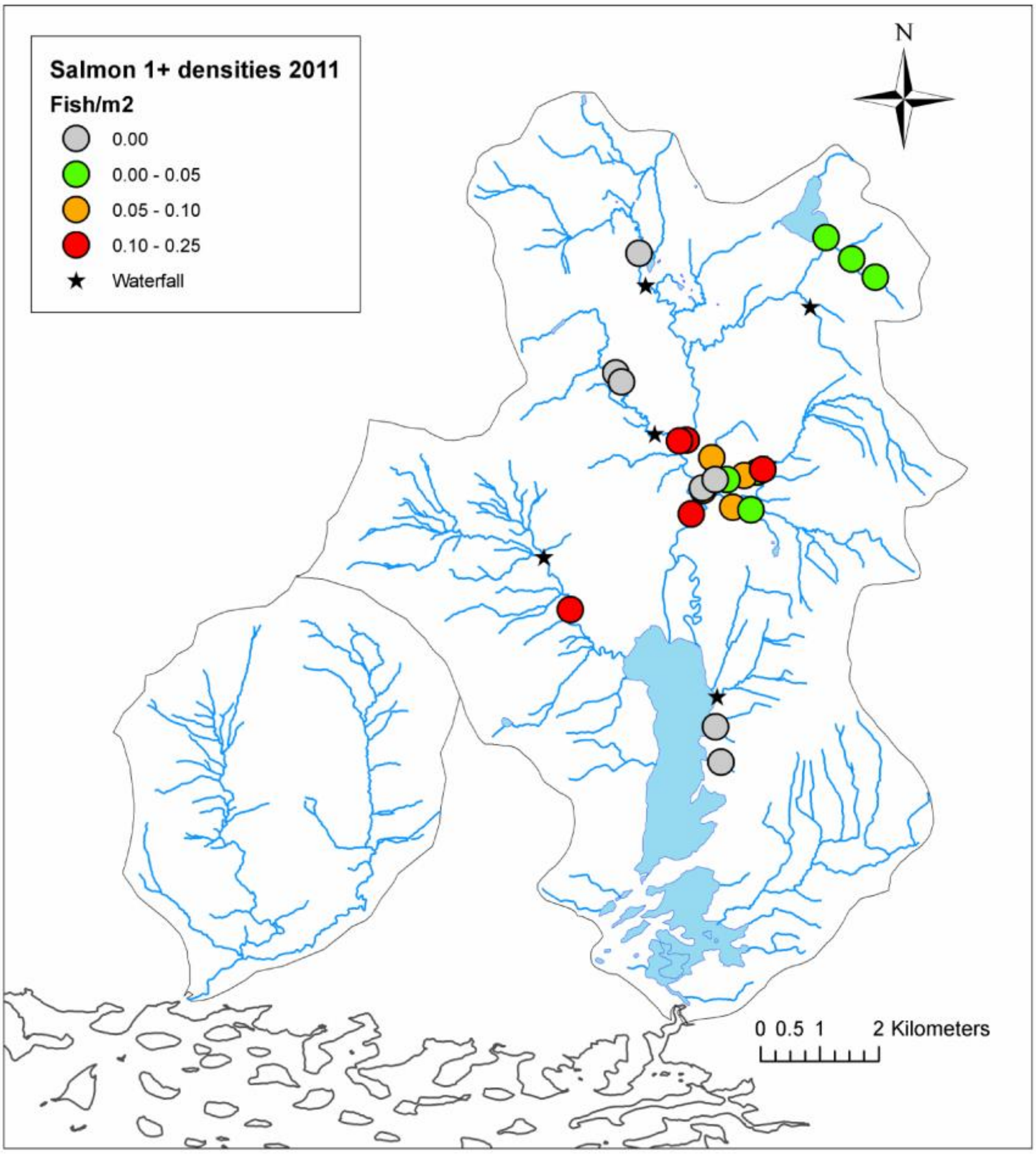

Figure 10-3: Densities of 1+ salmon calculated from the 2011 electrofishing survey of the Burrishoole and Owengarve catchment.

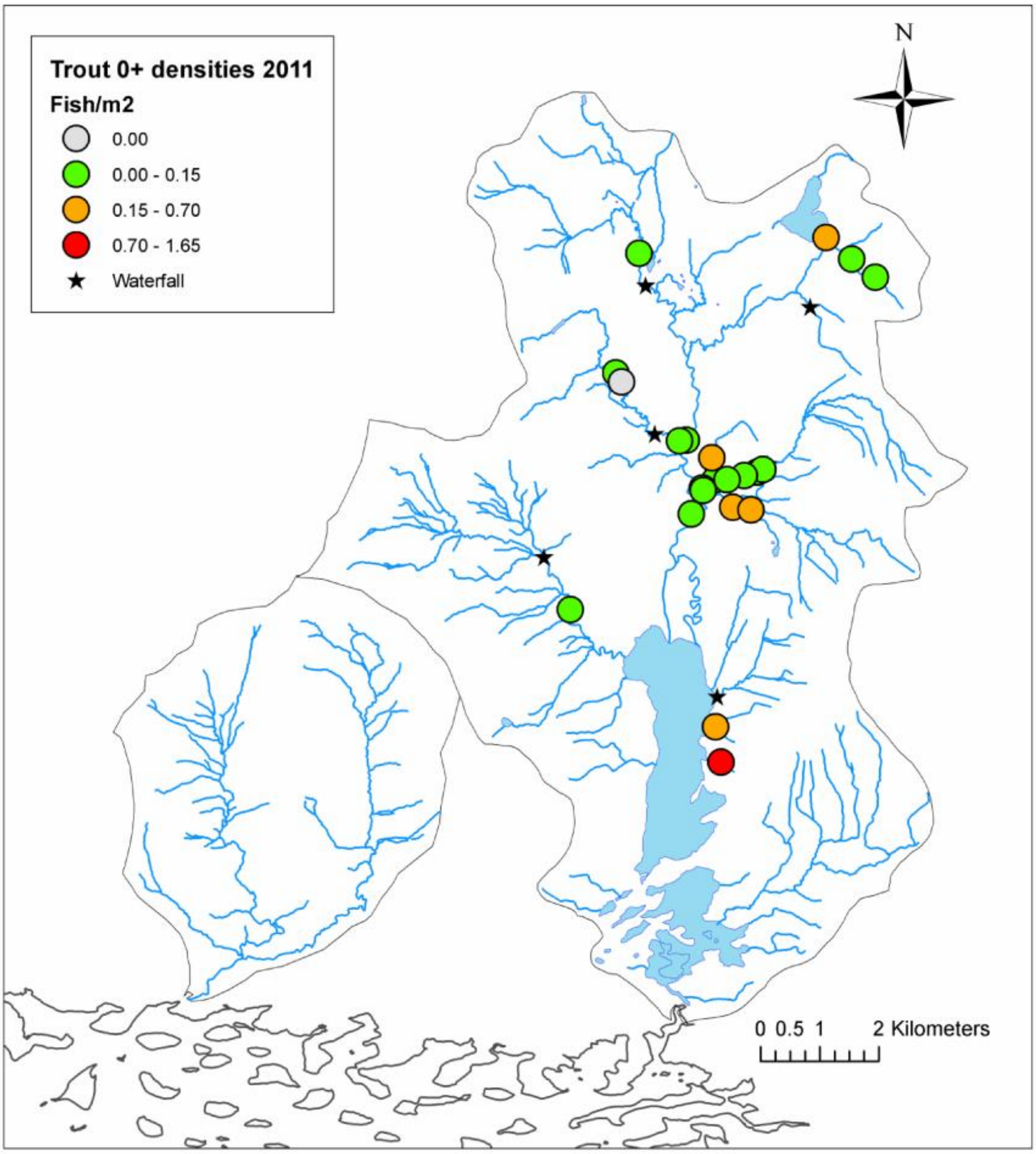

Figure 10-4: Densities of 0+ trout calculated from the 2011 electrofishing survey of the Burrishoole and Owengarve catchment.

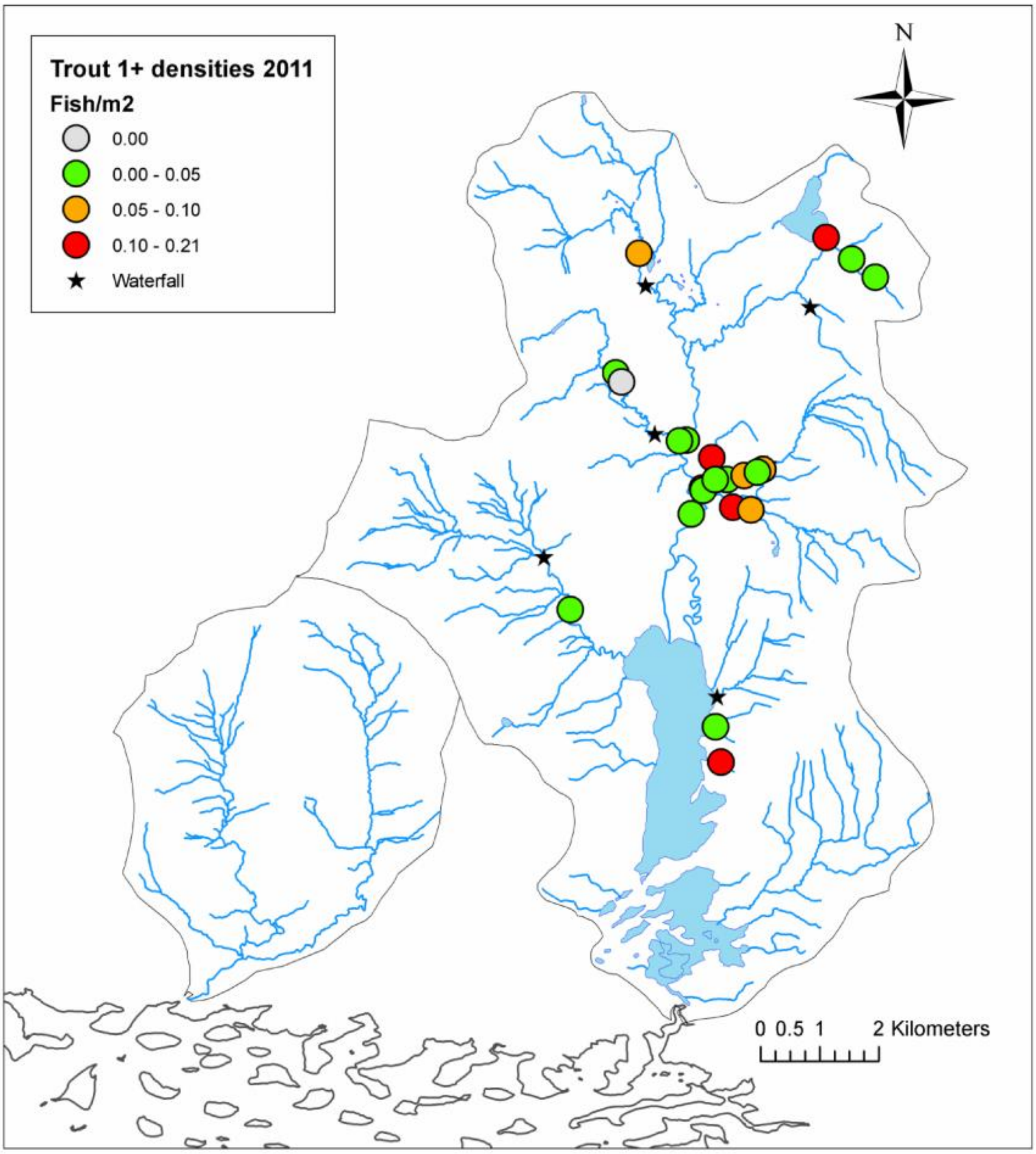

Figure 10-5: Densities of 1+ trout calculated from the 2011 electrofishing survey of the Burrishoole and Owengarve catchment.

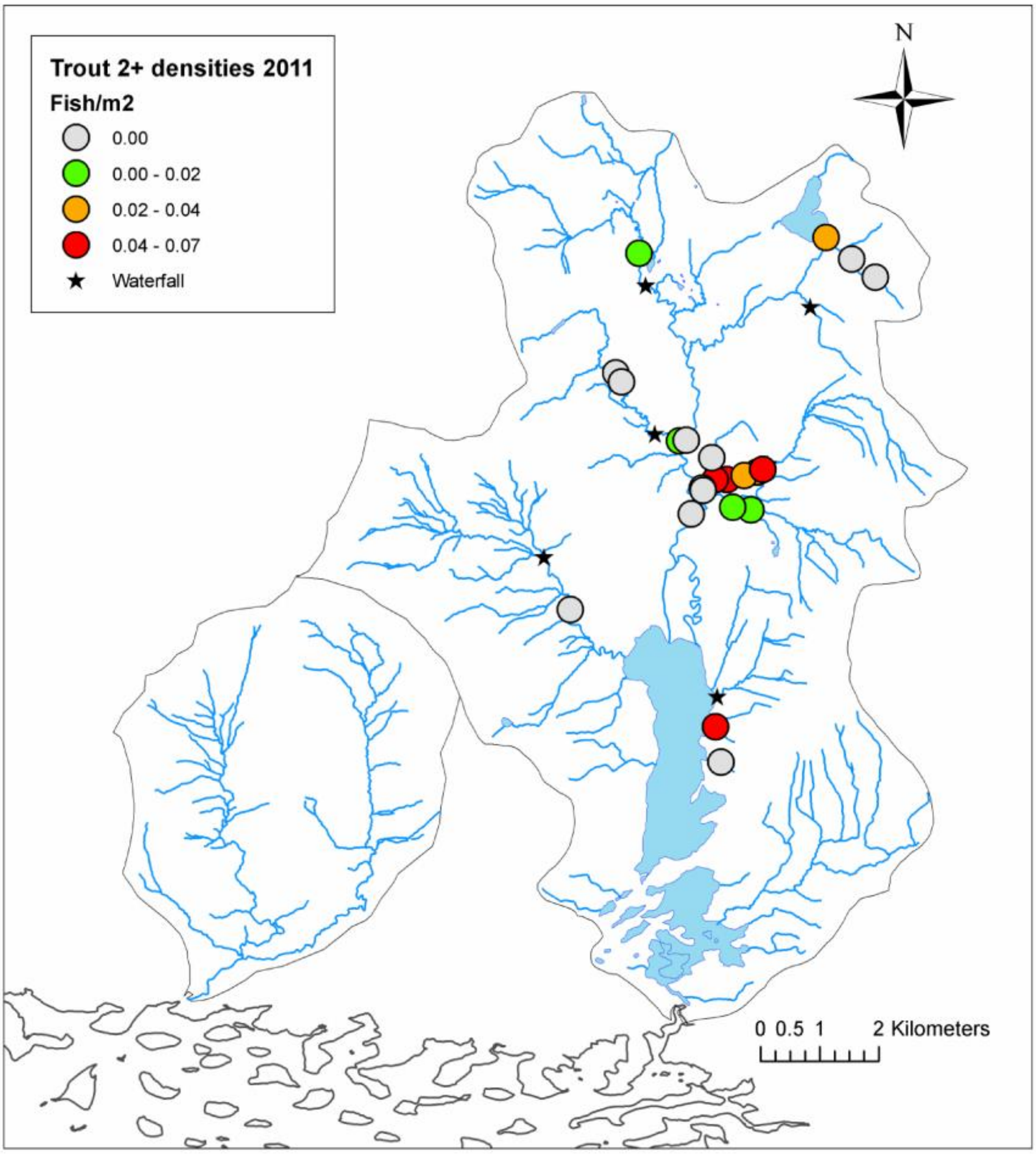

Figure 10-6: Densities of 2+ trout calculated from the 2010 electrofishing survey of the Burrishoole and Owengarve catchment.

Table 10-1: Catch details of the yellow eel survey carried out in 2011.

Lake	Dates	No. Eels	Net* Nights	CPUE	Total weight (kg)	Mean length (cm)	Mean weight (Kg)
Feeagh	26/07/2011	32	30	1.1	5.51	42.5 (30.1-84.7)	
	27/07/2011	43	30	1.4	7.68	43.8 (29.0-86.2)	
	2011	**75**	**60**	**1.3**	**13.19**	**43.2 (29.0-86.2)**	**0.173**
Bunaveela	28/07/2011	2	30	0.1		47.5 (38.4-56.6)	
	2011	**2**	**30**	**0.1**	**0.44**	**47.5 (38.4-56.6)**	**0.220**
Furnace	20/07/2011	15	30	0.5	1.85	40.5 (19.4-52.4)	
	21/07/2011	14	30	0.5	1.22	36.5 (30.7-44.5)	
	22/07/2011	6	10	0.6	1.70	47.6 (32.0-86.1)	
	2011	**35**	**70**	**0.5**	**4.77**	**39.9 (19.4-86.1)**	**0.140**
BOH	22/07/2011	19	20	1.0		46.5 (33.9-72.5)	
	2011	**19**	**20**	**1.0**	**3.68**	**46.5 (33.9-86.1)**	**0.193**

*** Net (pair of traps)**